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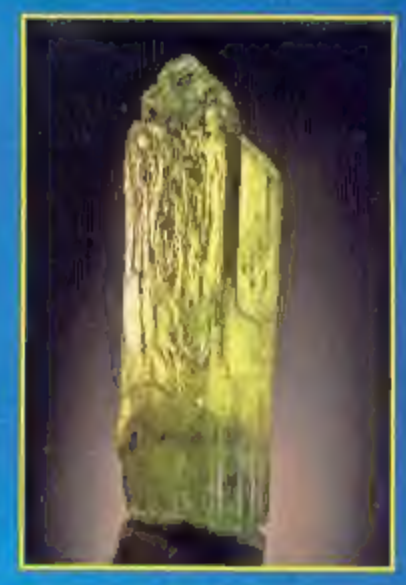

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ON THE COVER

This fine specimen of spessartine garnet, associated with schorl and quartz, hails from Pakistan and is part of the Irv Brown collection. (Photo by Jeff Scovil)

Miller Magazines, Inc.

Rock & Gem (ISSN 0048-8453, USPS 486-280) is published monthly by Miller Magazines, Inc., 290 Maple Ct., Ste. 232, Ventura, California 93003-3517, telephone (805) 644-3824. Periodicals postage paid at Ventura, CA 93006, and additional mailing offices. Single-copy price $3.99. Subscription in U.S.A. and possessions: 1 year (12 issues) for $24.00; 2 years for $42.00; 3 years for $54.00. Add $9.00 per year postage for Canada and all other foreign countries. Submission of articles and photos by our readers is welcome, but we can accept no responsibility for loss or damage to unsolicited editorial contributions.

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Printed in U.S.A.

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POSTMASTER: Send address changes to
Rock & Gem,
P.O. Box 469113, Escondido, CA 92046-9113
or RockAndGem@pcspublink.com

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THE FRUGAL COLLECTOR

Garnet

A Universal Gem

Story and Photos by Bob Jones

If the gem and jewelry world has a blue-collar worker, it has to be the many varieties of quartz. And if this is true, the gem world's executive officer has to be garnet, a group of colorful minerals that are found in almost every country and almost every type of rock environment.

Members of the garnet group are a major force in both the gem and mineral world. Garnet jewelry ranges from some of the most inexpensive you can buy to exceptionally costly jewels that compare favorably with emeralds. Like quartz, garnets can simply be picked up off the ground in some areas, while other garnet gems require sophisticated, costly mining methods.

For a time in the 1800s, garnet jewelry was the "in" thing for everyone. It seemed everyone could afford jewelry made from the red pyrope garnets from Bohemia. Lately, the most recent finds of garnets in Africa have raised this common gem to the level of a precious stone.

In the collector world, superb textbook-perfect crystals have come from a large number of places, with Alaska and Mexico among those better known. Mexico in particular has been a very prolific source for fine display specimens.

Garnet is really a group, rather than a distinct species, because the crystals come in six distinctly different, yet related, chemical compounds. All are either aluminum or iron silicates attached to one or more atoms of metallic elements called cations. These cations are totally interchangeable. Since any one of a half-dozen different metal atoms can substitute for each other in garnet, the species develops several interrelated varieties that form an isomorphous series. This means that as crystals develop, substitutions are rampant.

The general formula for a garnet uses the letters A and B to represent the metallic cations in the chemistry. These combine with silicon dioxide to create a garnet. The A stands for any one of four elements: iron, calcium, magnesium, or manganese. The B stands for a different and larger group of metal elements, including aluminum, chromium, manganese, titanium, zirconium, vanadium, and iron in a different form. If you know anything about math, you can immediately see that combinations of these metal elements can create a host of possible garnet varieties. Currently, we recognize some 60 different garnet varieties, most of which you have never heard of, nor will ever see!

Luckily, to bring order out of chaos, mineralogists group all these garnet varieties into six major garnet species. The species (and their most important cation elements) are: almandine (Fe and Al), pyrope (Mg and Al), spessartine (Mn and Al), andradite (Ca and Fe), grossular (Ca and Al), and uvarovite (Ca and Cr).

In the real world of garnet formation, there are so many variations on the ideal chemistry that within each of these groups we get a smorgasbord of varieties. Compounding that problem are the many local names applied to variations in color within a group.

EVAN JONES COLLECTION

With careful work, the bright-red grossulars from Mexico can be exposed.

HARRIS COLLECTION

This spessartine on albite is one of the finer garnets from the Little Three Mine in San Diego.

The Jeffrey Mine in Asbestos, Quebec, has been a superb source for gemmy cinnamon grossular, variety hessonite.

The garnet varieties have resulted in some odd names, like pyralspite, a mixture of pyrope, almandine and spessartine. Then there are local names like rhodolite, hessonite, cinnamon stone, hyacinth, melanite, rosolite, demantoid, scholomite, etc.

While we have condensed the garnet confusion to six major species, in actual practice there are 15 recognized garnet types, some with fanciful names like Transvaal jade and Mandarin stone, commonly referred to when describing jewelry stones. Of course, the potential for more varieties of garnet still exists. Look at the relatively recent discovery of the green gem garnet tsavorite. In the collector world, the recent discovery of beautiful red grossulars in Mexico has provided a superabundance of lovely specimens for collectors to obtain. Both these finds have been on the market less than 25 years.

Of the metallic elements that can occur in garnet, three elements, titanium, zircon and vanadium, generally play a role only in the composition of non-gem garnets like schorlomite, kimzeyite and goldmanite. On the other hand, iron, chromium, calcium, aluminum, manganese, and magnesium are most often seen in gem garnets. Therefore, we are more interested in collecting almandines, pyropes, grossulars, andradites, spessartines, and uvarovites. If only these members of the garnet group would behave themselves and not do all sorts of metal ion swapping, things would be a lot simpler. But the truth is there are virtually no pure members of the garnet series since each can play host to a mix of two or more metal ions. The result is some very colorful and sometimes valuable garnet gems!

What make garnets useful as gems are their variety of colors and their hardness of Mohs 6.5 to 7.5. Not all garnets are gemmy. Most are not vibrantly colorful, but virtually opaque or so dense in color they do not allow enough light to enter. But those that are clear enough to transmit light can be vibrantly rich and attractive.

Garnets develop in a great variety of rock types, mainly metamorphic schists and gneisses. But they are common in lesser amounts in granite pegmatites, granites, and volcanic rhyolites. They are even found in limestones.

Though garnets form in the isometric or cubic crystal system, they never occur as cubes or even octahedrons. The seemingly universal crystal form of garnet is the 12-sided dodecahedron. In fact, the term "garnetohedron" has been applied to crystals of any species that resemble the 12-sided garnet crystal form.

EVAN JONES COLLECTION

The dark red almandine garnets from Wrangell, Alaska, have been collected for decades.

Another less common, but very interesting, crystal form seen in garnets is a trapezohedron, crystals with 12 dominant faces and 12 smaller adjoining faces. Scientists sometimes call these complex 24-faced crystals icositetrahedrons.

While the common varieties of garnet like almandine and pyrope have been used for centuries, new varieties have pumped vital life into the garnet gem market. Garnets are on the rise in the jewelry trade today. New discoveries in Africa have brought a wonderful array of brightly colored tsavorite, hydrogrossular and malaya garnets to market. Tsavorite resembles emerald, while hydrogrossular is a massive green carving material and malaya is a bright red pyrope-spessartine mix found on the Umba River.

One of the unusual occurrences of pyrope garnet is the anthill deposits in the Four Corners area of Arizona and Utah. The garnets end up on the anthills as the industrious little creatures burrow their way underground, bringing to the surface all the bits of gravel in their way. Not much can be found here any more because rockhounds have scoured the desert washes and slopes of the region for anthill garnets.

The Arizona-Utah Four Corners garnet field is located not far from Monument Valley as the crow flies. There are actually three well-documented deposits, if we can call them that. The Garnet Ridge field is west of Chinle Creek in Arizona. If you cross the border into Utah, you come across the Moses Rock field south of the San Juan River. Still farther north is the smaller Mule Ear field, not far from Mexican Hat and the goosenecks of the San Juan River.

You might wonder why pyrope garnet is found in this remote region of largely sedimentary rocks. It's because the Four Corners area is shot through with volcanic intrusions called diatremes. Cathedral Rock, Ship Rock, and other geologic formations formed miles underground and pushed their way through surface sedimentary rocks to protrude like so many spires. The garnet-bearing diatremes are related to diamond-bearing kimberlites in that they contain several of the same gemmy minerals, including pyrope. If you take a raft trip down the San Juan, stop anywhere you see a diatreme near the river's edge and check it out. You might get lucky!

As a collector specimen, garnet can be very exciting. It forms abundantly as perfect textbook crystals, often jutting out of rock matrix. Such specimens can be as attractive as any other mineral.

Among the more popular, and now difficult to get, garnets on matrix are those from the Jeffrey Mine, an asbestos deposit near Asbestos, Quebec. Locally, these garnets are called cinnamon stone because of their delightful orange-brown color. Some of these grossular crystals are complex, showing tetrahexahedron modifications on the dodecahedron. They tend to occur closely packed together, intergrown as a platy arrangement on matrix. They are lustrous and gemmy, though they seldom exceed an inch in size. Some of the crystals occur singly on a white calcite matrix, and these are the most popular specimens.

continued on next page

Small gemmy pyrope crystals were once found in anthills in Northern Arizona.

The garnet family includes green demantoids, orange grossular, and bright-red pyrope.

More often, the grossulars are just tight plates of crystal faces. Many are less complex dodecahedrons. The larger crystals, those to an inch or so, can be faceted.

The Asbestos grossulars can be colorless, white, green, pink, or a lovely orange. For collectors, the better specimens come associated with bladed, green-gray vesuvianite.

A second asbestos-producing locality at Eden Mills, Vermont, has also produced fine grossular garnets. These garnets are a dark to light brown-orange color showing typical dodecahedron crystal forms.

Grossular garnets have emerged as one of the more important gem garnets, thanks to a remarkable discovery by my friend Campbell Bridges. Bridges lives in Africa and is a renowned geologist. In 1971, he was prospecting along the border of Tanzania and Kenya in the Teita Hills and found green grossulars of gem quality. A second deposit of green grossular was discovered in 1973 near Lualenyi, in Tsavor National Park, Kenya, hence the gem name tsavorite. The fine green gems were found in layered formations of graphite-bearing gneiss shot through with white marble, and are some of the most beautiful garnet gems ever found. These lustrous tsavorites have compared favorably with fine emeralds.

My favorite grossulars come from Mexico, and they are not gemmy! Just west of the border between the states of Coahuilla and Chihuahua is Lake Jaco, a usually dry lake. It can be reached by going east from Camargo on the main road from El Paso to Chihuahua City. Years ago, superb and startlingly large loose grossulars were reported to have occurred at Lake Jaco, but the garnets actually came from a region near the Sierra de la Cruz, a mountain range straddling the Coahuilla and Chihuahua border.

Initially, the huge garnets lay scattered over the eroded surface. They were mostly nearly perfect dodecahedrons. As surface pickings diminished, they were mined as specimens, most often with no matrix showing. Rarely, one would be collected with yellow-brown vesuvianite attached. None of these giants were gemmy, but their color was wonderful. Some were a sickly white, but most ranged from pale green to tan to a rather lovely pink. The largest I've seen are maybe 6 inches across, an impressive size even for garnets. You don't see these big dodecahedrons much any more, as the area is mined out.

Two huge known deposits have been developed in the Sierrea de la Cruz since the Lake Jaco deposit played out. At the north end of the mountain range can be found glossy black melanite garnets, a variety of andradite, in tight clusters. These opaque stones are still used in jewelry, not as faceted gems, but as natural crystal clusters mounted in silver. Their bright luster and perfect crystal form in small clusters make them attractive enough to be used as necklace ornaments.

Metamorphic deposits like the mica schist in Grafton County, New Hampshire, often yield fine almandine crystals, often with staurolite.

On the opposite side of this same mountain range is another profuse garnet deposit. This small prospect has produced some wonderful collector grossulars, bright-red perfect dodecahedrons in a silicified white limestone. Associated with the lovely red to pink textbook crystals are equally interesting mustard yellow vesuvianites to a half-inch wide and an inch or so long. The red crystals are seldom more than an inch across. Many have a white core, so the cause of color, manganese, came along in the later stages of the growth of each crystal. Sometimes, the core is a dark andradite, easily seen when a crystal is broken. Digging can be difficult, as the limestone is silicified in spots, but nice, undamaged crystal clusters are common here. Often, the limestone breaks away from the garnet crystals, but in some cases you may have to etch it away to get a nice matrix specimen. In any case, these grossulars are very showy, thanks to their rich raspberry red color.

Huge quantities of these lovely specimen garnets occur here. On one trip we made to the registered and claimed mine, enough garnet had been mined that we nearly filled the back of a pickup truck with boxes of garnets. Every rock outcrop I checked in the entire valley, every weathered boulder on the desert floor and on the mountain slopes, was shot through with garnets and vesuvianites. Mining here has produced huge quantities of specimen garnets, so now they are plentiful at shows. They are perfect for the Frugal Collector, since they are not exceedingly costly, are very colorful and showy, and in sufficient quantity to keep the price reasonable.

Another source for interesting collector-type grossulars is calcite-filled seams in a metamorphosed schist in Minot, Maine. This is a classic locality described in the early Dana texts from the late 1800s. Some of these crystals are perfect and over 2 inches across. It also produces vesuvianites with high luster, olive green to brown with deep striations. Not much has come from here lately, but maybe local collectors can change that.

One of the classic localities for grossular (named for gooseberries, which it resembles in color) is the Ala Valley on Mussa Mountain in Piedmont, Italy. When specimens of these lovely yellow-green to yellow-brown garnets surface, they command high prices, as they are uncommon and are considered classics. They are not suited for gem use, but make very attractive specimens.

The earlier-mentioned massive hydrogrossular called Transvaal jade is found on a couple of farms not far from Pretoria, South Africa. Hydrogrossular is green due to chromium, but it can shade into pink due to manganese, another example where two different metal elements share a berth in a mineral's structure. The green material has black specks of magnetite and chromite in it. It is compact and sugary looking, but it is certainly suitable for lapidary work. The exciting thing about Transvaal jade is the red mineral locked in the green hydrogrossular. No doubt you have seen superb blue-red ruby crystals in perfect hexagonal form locked in this green stone, a lovely, Christmassy combination. The ruby is not transparent, but when domed and polished shows a superb schiller effect, which a skilled artist can bring out during carving.

Spessartine, or spessartite, crystals are not very common. The first of these orange to orange-red garnets were found in the Spessart district of Bavaria, but the most important gem spessartines are found in pegmatite deposits in the United States, particularly in Southern California. Not all spessartines are found in pegmatites. The rhyolite outcrops around Ely, Nevada, have perfect textbook crystals of spessartine, so dark as to appear black, in small cavities. The area is tough collecting, so I doubt it will ever be stripped of garnets, for they occur randomly in the hard rhyolite.

In modern times, the major source for spessartines has been pegmatites in San Diego County, California. Three related mines—the Little Three, the Spalding, and the Hercules—have been excellent producers, though they have never produced these lovely yellow-orange gems in huge quantities. The mines are all on the same hill. The garnets occur only sporadically, usually with lustrous black schorl tourmaline, crystallized albite, and quartz crystals. They are a rich orange color with high luster and make superb faceted gems that are much sought after. These mines are not working today, so don't expect to see much spessartine from San Diego.

Another pegmatite that has produced fine spessartine crystals is on the East Coast. The Rutherford #2 mine, along with the Rutherford 1#, is located near Amelia Courthouse, Virginia. Back in the late 1800s, these mines were producing spessartines of considerable size. The largest reported single crystal weighed over 6,700 carats, which translates to about 3 pounds! That's an amazing size for any spessartine! These mines are also well known for gem amazonite, massive material that can be worked by the lapidary. The last time these mines were seriously worked for gems and specimens was after World War II, by John Sinkankas. This effort produced some fine, though rather corroded, material that is no longer seen for sale these days.

Collectors who would like to get some nice spessartines might check out Ruby Mountain in Nathrop, Colorado. Across the Arkansas River from state Route 24, Ruby Mountain is a vuggy rhyolite dome in which may be found small topaz crystals and even smaller bright-yellow spessartines. A search of the gravels around the skirt of the mountain is sometimes fruitful. My efforts here have been largely unsuccessful, with one or two small exceptions!

Another garnet that is sometimes found in specimen quality is andradite. What's interesting about andradite is its variety of names: topazolite, polyadelphite, melanite, and green demantoid. These names reflect the variety of colors seen in andradite.

Perhaps the most valuable of the andradite bunch are the Russian demantoid crystals first found in 1868. These bright-green gems are also called Uralian emeralds. The tiny, chromium-rich garnets were found as gemmy crystals during gold mining in the Nizhni-Tagilsk area of the Ural Mountains. While panning and sluicing for gold, the miners noticed the crystals and prospectors discovered the source. They are generally too small to be faceted, but the larger ones have been used in jewelry. Similar green, gemmy andradites have also been found near Kuusamo, Oulu, Finland. These can reach an inch in size, but tend to be opaque in the larger sizes, and are locked in nepheline syenite.

A second variety of andradite is called topazolite because of its strong yellow-brown color. Nice specimens have been found in San Benito County, California, but are not common, and few are suitable for gem use.

While San Benito County is noted for its benitoite, the Franklin and Sterling Hill, New Jersey, areas are best known for their amazing assemblage of zinc minerals: more than 200 uncommon and rare species, including willemite, franklinite, zincite. Occasionally, really nice andradite garnet crystals are found locked in the limestone here. They tend to be reddish to dull yellow, an inch or so in size, and usually slightly rounded. They are not common, so collectors in the Franklin/Sterling Hill area prize what they have; you'll seldom see them for sale.

In the last few years, some rather fascinating iridescent andradites have been found in Mexico. They come from somewhere in the state of Sonora and can be cut into interesting gems. If they did not have a play of colors, they would simply be ordinary garnets of modest value. But the color play makes them special, and keeps them out of reach of the Frugal Collector.

The most interesting deposit of demantoids is at Magog, Stanstead, Quebec, where bright-green crystals a few millimeters across occur aligned on tan to gray diopside that looks more like petrified wood than real petrified wood does. The material is more a curiosity than an exciting collector mineral, since the garnets are so small and the diopside quite unattractive.

Arizona has a huge deposit of andradite garnets. Again, none of the crystals are gem quality, but mostly opaque to cloudy crystals not suited for gem use. Still, the deposit is vast and capable of yielding tons of specimens. Unfortunately, the area, Stanley Butte, is virtually closed to collectors, as it is on the Apache Indian Reservation near Globe. The garnets occur as thick seams of massive garnet in a marble skarn, with abundant open vugs lined with sharp bronze-green and olive-green to olive-brown dodecahedrons. The better specimens have clusters of free-standing crystals, but most specimens are covered with tightly clustered garnet faces where only half the crystal juts above the matrix. The interesting thing about these crystals is the

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schiller effect some show. These can be domed and used as ring stones. Rotating a specimen in a strong light will sometimes reveal this play of colors.

I said Stanley Butte is "virtually closed" because only Native Americans are allowed to dig here. You have to connect with someone who is allowed to dig there in order to get specimens or buy them locally.

Of all the garnet crystals to be found, the almandine variety is certainly the most common. They are also the least useful as a gem because the color is usually too dark. Still, there are almandines that are really exciting as gems, like the star garnets from around Lewiston, Idaho. There's fee digging, prospecting, and casual mining in the area. Huge quantities of garnets have come from here, perhaps as much as 10,000 tons.

The four-ray star seen in almandine garnets is due to included rutile needles, oriented along the two axes that sit at right angles to the central third axis. This is a reflection of the cubic crystal form of garnet. On really rare occasions, an Idaho garnet will show tiny six-ray stars at the tips of the four-ray image, due to twinning of the rutile needles. The better star garnets seem to come from the Emerald Creek area, which parallels state Route 447 west of Clarkia.

I guess I have a natural affection for almandine garnets, since the first successful collecting trip I ever had as a youth was to the garnet dig in Roxbury, Connecticut. Before the farm owner closed the place down, I think every mineral collector in the East had enjoyed the profusion of garnets found here. You could walk along the dirt road leading into the old mine and pick up as many loose, perfect dodecahedron garnets as your pockets could hold. This was heady stuff for a young collector. I can honestly say the Roxbury locality probably did more to ignite my interest in collecting minerals than any other single thing.

The deposit was actually worked intensely as a garnet source for the making of garnet sandpaper. The Roxbury crystals are simple dodecahedrons and deep red, too deep to be suitable for gem use. The crystals are usually an inch or so across, with a few larger than that. They occur in a crumbly metamorphic schist rock that is also loaded with single staurolite crystals. These perfect almandine crystals are excellent for study use and have been so used in crystal identification kits.

An even larger and more important industrial source of sandpaper garnet is Gore Mountain in the Adirondack Mountains of New York. Here, the almandine garnet occurred as a bright-red, solid crystal sections, and less often as fine crystals that were anywhere from 2 inches to 6 inches across. Rarely, huge, crude crystals to 2 feet across were found during mining, but the bulk of this garnet is massive crystalline in a black hornblende matrix. This deposit began producing in the 1880s and continued until 1984. The major mine was the Barton garnet mine, where for a time after mining ceased, fee digging was allowed. Some of the garnet crystal sections here are gemmy enough to be faceted, though they tend to be a bit dark.

While the Gore Mountain garnets were huge, they were not unique. Back in

These grossulars and yellow vesuvianites were found in the mountains east of Lake Jaco, Chihuahua.

Roman times, large garnets were even carved into drinking cups large enough to hold a pint of liquid. Carving cups out of garnet crystals was not uncommon, but it must have been some fun to carve this hard mineral. Luckily, it doesn't have a perfect cleavage, so it could be worked without fear of parting.

The almandine locality that produced more perfect textbook dodecahedral crystals than any other in recent years is along the Stikine River in Alaska. The garnets come from a micaceous schist formation that is loaded with superb red crystals. The area has been known for many decades. Serious mining went on here at one time. The deposit has provided superb study crystals for school mineral kits and educational projects.

The Stikine River crystals tend to be fairly uniform in size, just under and inch, though some are larger. They often have minor mica inclusions on the surface, but are otherwise in excellent shape. Matrix specimens with well-exposed crystals in mica schist can be seen in virtually every museum display. Collectors were able to mine specimens here for decades until some greedy type did a lot of damage using dynamite. Since that time, the place has been turned over to scout groups that collect crystals to sell, a noble fundraising effort.

Still another source of large garnet crystals is the Sedalia iron mine near Calumet in Chaffee County, Colorado, where the garnets are up to 10 inches across! They are not particularly attractive; their surface has included greenish chlorite, also found here in dull prismatic crystals. The garnets are usually locked in massive chlorite.

Of all the garnet group members, the least common is uvarovite, a variety found in 1832 near Bisserk in Russia's Ural Mountains. It was named for Count Uvarov, who was president of the Saint Petersburg Academy at the time. The crystals are always small, too small to be faceted. Yet, their bright-green chromium-induced color makes them a very exciting garnet variety. Since the Russian discovery, uvarovite has been found in Finland and in the Bushveld Complex in South Africa, as well as in several other places. Perhaps someday, crystals of facetable size will be found.

With at least six distinct garnet types and myriad varieties within this half-dozen, the Frugal Collector should be able to add a nice variety of garnets to a collection. Garnets are among the more common species found on Earth. They occur worldwide at thousands of localities, many of them little more than an outcrop. While the major known mines are the most important source for specimens, careful research in any given geographic area may provide the Frugal Collector with opportunities to find nice specimens. For example, you can find small gemmy bits of garnet in western North Carolina, in Cowee Creek and elsewhere. There are usually a half-dozen fee digging rock shops in the area, so a collector can have fun going through gravels.

Since garnets occur widely, there is a good possibility that not all deposits have been uncovered. Witness the recent tsavorite find by Campbell Bridges in Africa and the find of lovely raspberry grossulars in Mexico. Any metamorphic rock formation deserves a look. The constant professional search for gem varieties will also inevitably unearth hidden specimen sources, and the Frugal Collector should have no trouble collecting nice examples of this remarkably prolific multicolored silicate.

SHOP TALK

William A. Kappele

Clamps, Coolant and Carvings

In this month's column, I decided that it was time to catch up on another batch of odds and ends. I'll begin with a little discussion of clamps. These great helpers are needed for all kinds of projects around the shop, and we never seem to have enough of them. Of course, they come in all sizes, shapes, styles, and qualities. Most of our needs will probably be for small clamps, since our lapidary and jewelry projects are usually small. We are also lucky in that we don't usually need anything very special (read expensive).

Simple bulldog clips from the stationery store or the dime store work great for all kinds of clamping jobs. Alligator clips from places like Radio Shack can be had in a wide range of sizes and work on all kinds of things besides alligators. One of the niftiest clamps from the medical industry is the hemostat. You might even get some old freebies from your doctor (unless he left them in a patient). If you don't know what a hemostat looks like, you can see them at www.scissorsales.com/hemostat.html.

Don't forget about locking tweezers for holding those tiny stones and other little bits and pieces. Finally, certainly the cheapest, and often the best, is the good old-fashioned spring clothespin. Even in this day of the clothes dryer, you can still buy them. If you can't find them locally, try www.polsteins.com/pencormfr18w1.html.

I came across some information on the Internet a while back about using soybean oil as a saw coolant. It seems that if you live in cold country, you don't want to use it. The Internet writer left his saw in an unheated shop over the winter, and when he tried to use it in the spring, nothing would move. He tried all kinds of solvents, including gasoline and paint and varnish remover, but finally had to take the saw to a steam cleaner, who worked on it for an hour to get the congealed mess cleaned up enough to use. So if you were thinking about using soybean oil in your saw, you might want to cross it off your shopping list.

Disclaimer: Be aware that a lot of misinformation is circulated on the Internet. Before taking any advice you find on a Web site, verify it through a reliable source.

I have always admired stone carvings, but have never tried carving since, on a rating scale, my artistic ability is just below paint-by-numbers. I did get an idea while wandering around a giant flea market in Yuma, Arizona, a while back. I noticed several large tables with ironwood carvings from Mexico, which is about 30 feet from Yuma. Much of the ironwood was really nice, with fine grain patterns, strategically placed small knots, etc. The carving itself, though, was pretty rough. There were lots of sharp edges, poorly incised lines and so on. Of course, they were priced very low.

My idea was to take one of these rough carvings and finish it. I thought I would be able to handle that, since my problem is not with being able to shape wood, metal or stone, but in working out the basic shape. I know the old story that to carve an elephant in jade, you just grind away everything that doesn't look like an elephant. If I tried, when I finished, I would have a (small) block of jade that didn't look like an elephant. The pieces that did look like one would be all over the shop floor. I confess that I haven't tried my idea yet, but some of you might find this a way to gain some confidence in carving without ruining some expensive material. You might even begin to see which parts of the wood or stone don't look like an elephant.

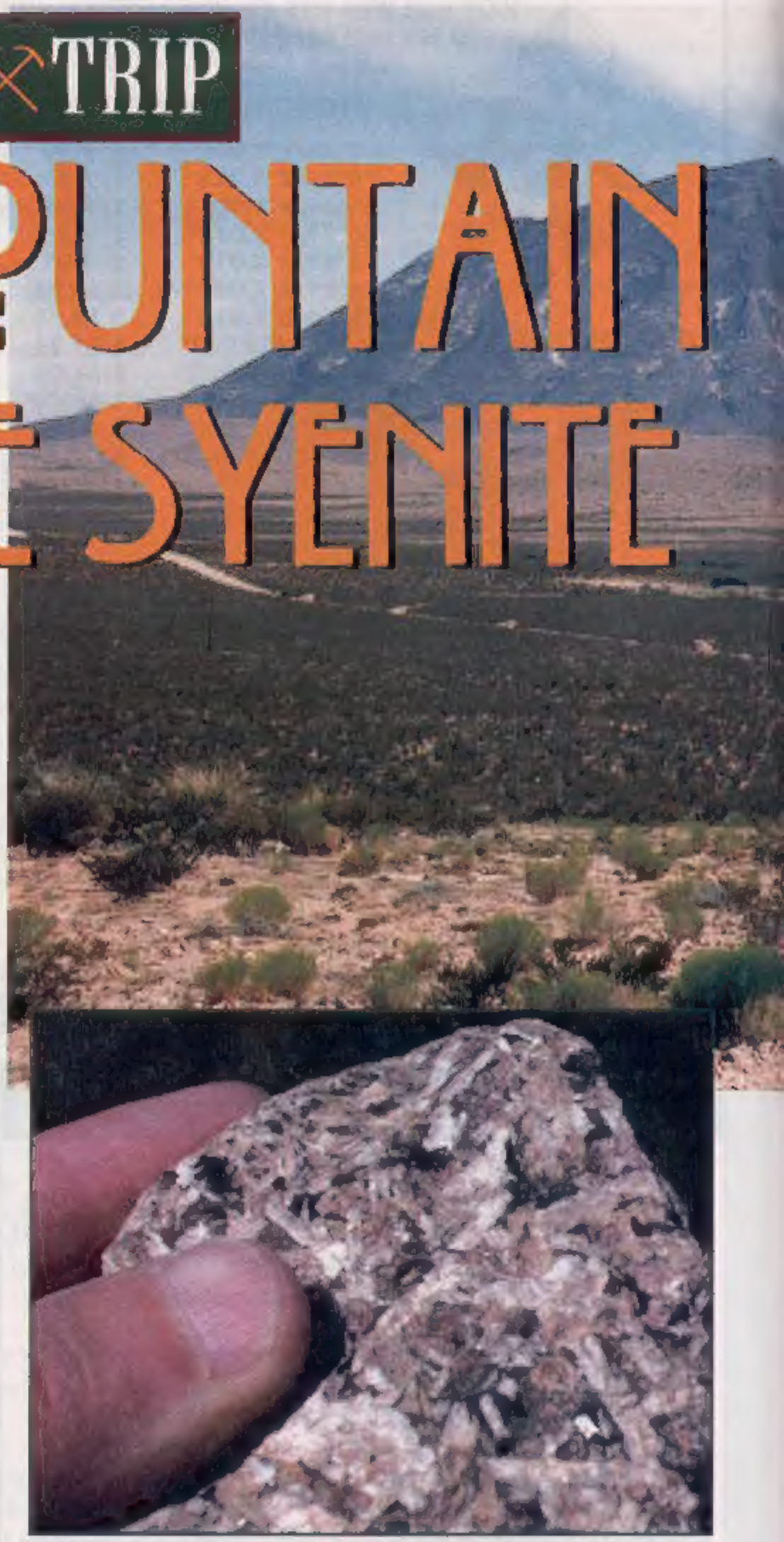
Please feel free to contact me if you have a suggestion or comment about this or any of my Shop Talk columns. My e-mail is quappelle@cox.net, or write to me at 25231 Pericia Dr., Mission Viejo, CA 92691.

FIELD TRIP

WIND MOUNTAIN NEPHELINE SYENITE

Feldspathoids and Rare Earth Minerals in the Cornudas Mountains

Story and Photos by Robert Beard



The Cornudas Mountains, located on the New Mexico-Texas border in Otero and Hudspeth counties, are an area that very few people visit. It is not hard to see why. It is well away from highways and population centers, and at first glance it does not appear to have much to offer.

Cornudas is Spanish for "horned." The mountains presumably got this name from the way they protrude from the surrounding terrain. They consist of nine distinct, barren peaks that rise abruptly from the Otero Mesa, and are a major change from the surrounding flatlands. One of peaks is named Cornudas Mountain, as it is shaped like it has horns. The largest peaks are Alamo Mountain, Chatfield Mountain, Flat Top, Black Mountain, and Wind Mountain.

The mountains did not have much to offer the early settlers, as the soils on the slopes of the mountains were shallow and sandy, and supported mainly scrub brush and cacti. Although the mountains had springs, there were no perennial streams nearby and no metallic mineral deposits to mine.

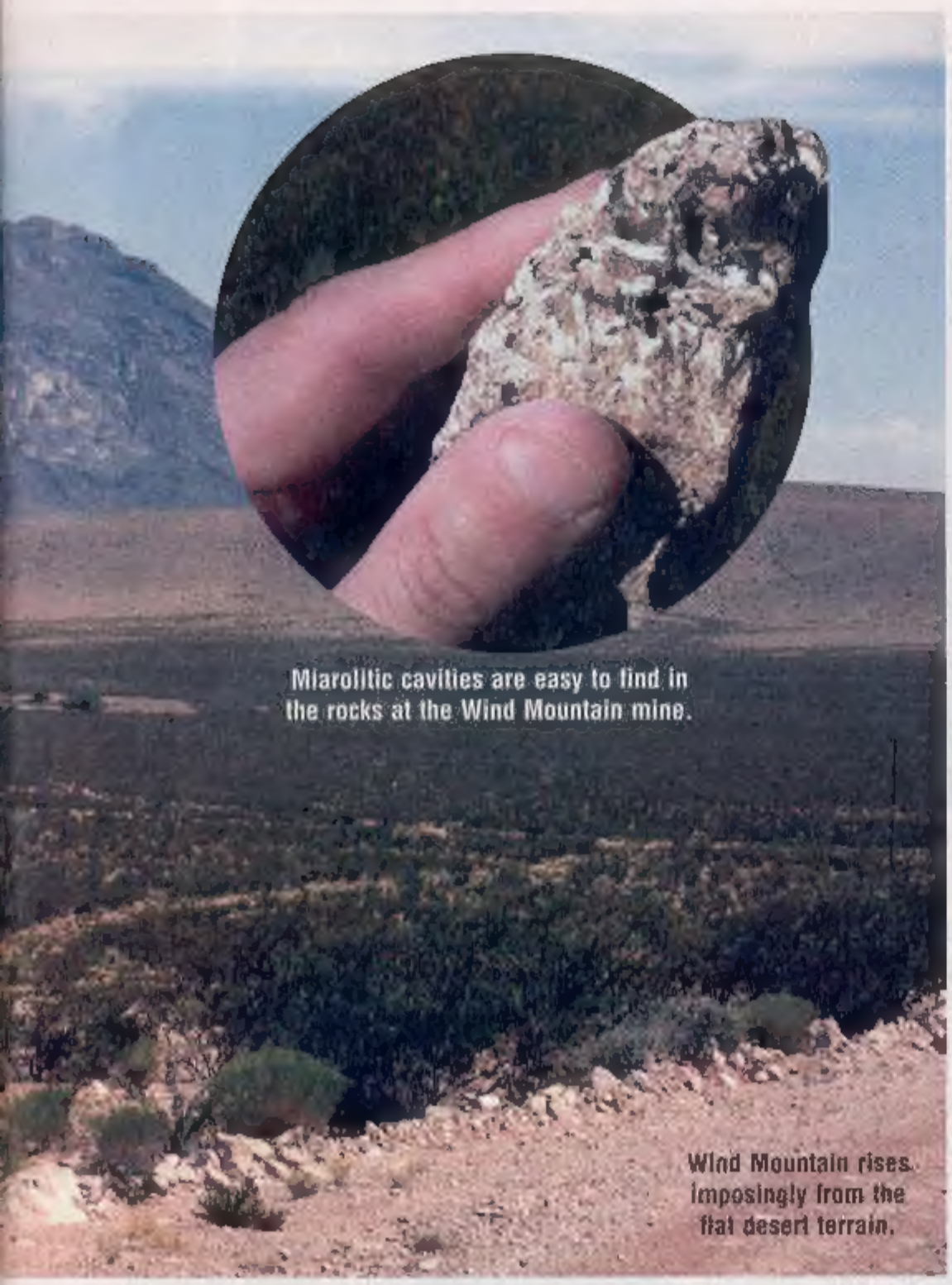
The Cornudas Mountains lie within the northern part of the Trans-Pecos magmatic province, which extends roughly from the Big Bend area of west Texas into the southern part of New Mexico. This province is part of a much larger belt of Cenozoic calc-alkalic igneous rocks that extends much farther north through the Rocky Mountains and into the western coast of Canada. Early on, geologists recognized that these rocks were relatively high in chlorine, fluorine, strontium, zirconium, and rare earth elements, and many significant mineral deposits were found along this trend. Several unusual mineral deposits have been discovered in the Trans-Pecos magmatic province, including deposits of molybdenum and beryllium.

The Cornudas Mountains consist of numerous Late Eocene to Oligocene laccoliths, sills, plugs, and dikes that intruded relatively flat-lying Permian and Early Cretaceous limestones and other sedimentary rocks. The intrusives are mainly nepheline syenites, phonolites, and trachytes. These formed from magmas that were deficient in silica, but enriched in potassium and sodium.

The nepheline syenite is a complex assemblage of light-red and light-green minerals among the potssium feldspars and hornblendes.

Felsic (light-colored) intrusive igneous rocks that are low in silica but enriched in potassium and sodium are relatively rare. Most have a high proportion of silica, which crystallizes into quartz and results in granite and granodiorite. Since granites and granodiorites are so common, many beginning collectors and even experienced geologists assume that any coarse-grained, light-colored igneous rock can be called granite.

Fortunately, it is very easy to tell the difference in a hand sample. If you can see quartz, it is almost certainly going to be classified as either a granite or granodiorite. The quartz is usually easy to spot, often forming dark- to light-gray anhedral grains between the feldspars, biotites and hornblendes in the rock. The quartz is often one of the last minerals to crystallize, so it forms between many of the minerals that crystallized earlier.



Miarolitic cavities are easy to find in the rocks at the Wind Mountain mine.

Wind Mountain rises imposingly from the flat desert terrain.

An adit has been driven into Wind Mountain for extraction of the nepheline syenite.

The nepheline syenite porphyry forms striking patterns in outcrops and boulders.

This is not a purely academic exercise. For the exploration geologist or mineral collector, it is very important to recognize when you are dealing with felsic, low-silica, alkalic intrusive rocks; they can contain feldspathoids, which are the minerals that form instead of feldspar when a melt is rich in sodium and potassium, but deficient in silica. The principal feldspathoids are nepheline and sodalite, but lazurite, leucite and petalite are also feldspathoids. Feldspathoids have a higher aluminum to silicon ratio (1:1) than feldspars (1:3), and their crystal structure is similar to that of zeolites, with open spaces that allow for large ions such as chlorine, carbonate and sulfate. However, unlike zeolites, the openings are largely separate from each other and do not allow for movement within the structure. The open crystal structure also results in a lower density than feldspar's.

For the industrial minerals geologist, nepheline is by far the most important of the feldspathoids. When nepheline, (Na, K)$AlSiO_4$, is compared to potassium feldspar, $KAlSi_3O_8$, it is easy see that nepheline has a higher aluminum:silicon ratio and a lower ratio of silicon:oxygen than potassium feldspar. Nepheline is used in the glass industry for containers and bottles, as the higher proportion of alumina decreases the tendency of the glass to devitrify and improves its durability with respect to chemicals. The sodium and potassium also act as a flux and lower the melting point of the glass. Nepheline is also used in the production of vitreous whitewares, glazes and enamels, and as filler in paints, rubber and plastics. In the former Soviet Union, the high aluminum and alkali content made nepheline a source of alumina (Al_2O_3), caustic soda (NaOH), potassium chemicals, and cement. Petalite, $Li(AlSi_4O_{10})$, which is a lithium-bearing feldspathoid, is another important feldspathoid used by the lithium industry, but it is much less widespread than nepheline.

For the mineral collector, sodalite and lazurite may be considered the most important feldspathoids. The distinctive feature of both of these minerals, and what makes them desirable, is their blue color. Sodalite, $Na_8(AlSiO_4)_6Cl_2$, is a relatively rare rock-forming mineral associated with nepheline syenites, trachytes, phonolites, and other silica-deficient igneous rocks. It gets its name from its high sodium content. Lazurite, (Na, $Ca)_8(AlSiO_4)_6(SO_4,S,Cl)_2$, which is also rare, generally forms as a result of contact metamorphism in crystalline limestones. Lazurite is best distinguished from sodalite by the presence of associated pyrite in lazurite, which is absent from sodalite. The vastly different occurrences of intrusive igneous for sodalite and contact metamorphic for lazurite are quick ways to distinguish between sodalite and lazurite in the field. However, as both of these minerals are rare, if you are in a position to collect them, you will almost certainly know which one you are dealing with.

Low-silica alkalic intrusives sometimes also have high concentrations of rare earth elements, niobium, zirconium, and titanium. The rare earth elements (REEs) form the largest chemically consistent group in the periodic table. Although many people are unfamiliar with them, REEs are indispensable for hundreds of applications, and have become critical materials. Over the last 10 years, the United States has become more dependent on imports of REEs, mainly from China.

The 16 REEs are lanthanum (La); cerium (Ce); praseodymium (Pr), neodymium (Nd); Promethium (Pm); samarium (Sm); europium (Eu); gadolinium (Gd); terbium (Tb), dysprosium (Dy); holmium (Ho), erbium (Er); thulium (Tm); ytterbium (Yb); lutetium (Lu), and yttrium (Y). Some of their applications include magnets for computers and disk drives, catalysts in petroleum refining and catalytic converters, fluorescent lamps, and magnetic refrigeration technology.

continued on next page

Wind Mountain Nepheline Syenite *from page 21*

The most important REE minerals from an industrial standpoint are monazite, $(Ce,La,Th,Nd)PO_4$, which is a phosphate, and bastnasite, $(Ce,La)CO_3F$, which is a complex fluoracarbonate. For the mineral collector, eudialyte is perhaps one of the best known collectable REE minerals. Eudialyte has a complex formula, $Na_{4}(Ca,Ce)_2(Fe^{+2},Mn^{+2})_3YZrSi_8O_{22}(OH,Cl)_2$, which indicates the two REEs present in this mineral are cerium and yttrium. One of the best known collecting localities for alkalis and rare earth minerals is Mont Saint-Hilaire in Quebec, which has beautiful red and pinkish red eudialyte. I obtained a eudialyte sample from Mont Saint-Hilaire at the Gilsum Mineral Swap in New Hampshire, and it is one of my most prized pieces.

Geologists have explored the Cornudas Mountains for decades, and have looked closely at their potential for nepheline syenite, REEs, and radioactive minerals. A deposit of nepheline syenite on the southwest side of Wind Mountain was investigated by Addwest Minerals of Arvada, Colorado, and eudialyte has been reported in the area of Wind Mountain by at least a couple investigators. However, no significant economic deposits of minerals have been exploited to date.

The New Mexico Bureau of Mines and Mineral Resources (NMBMMR) developed a mineral collecting guide to Wind Mountain. Contact the Bureau at (505) 835-5420 to obtain this reference, written by Virginia T. McLemore. It has useful maps, references, and a list of the minerals and rock types to be found in the Cornudas Mountains. The road log is also extremely detailed. McLemore recommends the 7.5 minute, 1:24,000 USGS topographic maps Cornudas Mountain and McVeigh Hills, and the 1:100,000 USGS topographic map Crow Flats.

The area is also referenced in a 1950 abstract by S.E. Claybaugh entitled "Eudialyte and Eucolite from Southern New Mexico," in the *American Mineralogist* (Vol. 35, pp. 279-280). This abstract describes the eudialyte as small, subhedral to euhedral crystals, about 0.5 millimeters to 3 millimeters in diameter, and rose pink and brown to colorless. Additional technical descriptions are given in two abstracts by R.C. Boggs in *New Mexico Geology*. The 1985 article is "Mineralogy of the Wind Mountain Laccolith, Otero County, New Mexico" (Vol. 7, pp. 41-42), and the 1987 article is "Mineralogy and Textures of a Eudialyte-Bearing Dike, Wind Mountain, Otero County, New Mexico" (Vol. 9, p. 22). Both are included in the Wind Mountain collecting guide available from the NMBMMR. While interesting, they do not contain any maps or other information that allows one to easily find the eudialyte-bearing dike.

The mine dumps on the southwest side of Wind Mountain are easy to spot and access once you are near them.

Another useful publication that can be obtained from the NMBMMR is the 1993 book *New Mexico Geological Society Guidebook, Carlsbad Region, New Mexico and West Texas*. It contains an article by Virginia T. McLemore of the NMBMMR and James R. Gallinger of Addwest Minerals entitled "Geology and Mineral Resources of the Cornudas Mountains, Otero County, New Mexico and Hudspeth County, Texas." This very useful article has a geologic map of Wind Mountain and many additional references.

The Wind Mountain locality is also described in *New Mexico Rockhounding* by Steve Voynick (1997, Mountain Press Publishing Co.). This book describes the mineral suite as similar to those found at Mont Saint-Hilaire, but also notes that it produces mostly micromount minerals. It describes the site as for "experienced collectors and amateur mineralogists capable of identifying the micromount specimens."

I am so near-sighted my eyes act almost like a huge magnifying glass without my glasses, so I figured that I could appreciate the micromounts. I was also interested in finding eudialyte, since my piece from Mont Saint-Hilaire is so unusual. However, Voynick states that this is remote, arid country, and that "collectors planning to visit Wind Mountain should obtain topographical maps and pack ample food, drinking water, fuel, and emergency supplies." Whenever I see a warning like this in a guide, it usually means that I am in for a rugged trip.

I originally visited the Wind Mountain area in 1988 when staking some gold mining claims. At the time, I was not paying much attention to the unique mineralogy of the place, as I was under the impression that most of the minerals were micromounts and would not be of much interest to me. Unfortunately, after I staked my claims, I moved away from New Mexico, and due to the total absence of gold on my claims I never bothered to pay the claim filing fees.

However, when researching the region in July 2004, I decided that it would be worth revisiting the Wind Mountain area to check out the nepheline syenite quarry on the southwest side. A two-wheel drive Cutlass Sierra rental car may not seem the best vehicle for driving in the Cornudas Mountains, but the NMBMMR field trip guide indicated that two-wheel-drive would be OK, and my recollection of my 1987 trip was that the roads were suitable for a regular car.

On the map, it appears that the Cornudas Mountains are very close to El Paso, and that it would not take long to get there. However, once I got off the highway, the dirt roads slowed me considerably. I drove and drove, and finally reached the reported turnoff point in the field guide. I continued on additional dirt roads for miles, and found that my copies of the topographic and area maps were just awful. Nothing seemed to match up with the roads I found, but I eventually located myself on the map. The road from the road log then crossed the New Mexico-Texas border, and at this point I was really frustrated when I came to a locked gate. The NMBMMR guide made no mention of a gate. I was stuck. Although I had been on public land in New Mexico, based on my information from the *New Mexico Road and Recreation Atlas* published by Benchmark Maps of Berkeley, California,

apparently the land status changed when you entered Texas. I was also using *The Roads of New Mexico* (1998, Sheater Publishing), an excellent reference for New Mexico, but it, too, cuts off at the border, so the potential access route from Texas remained a mystery. I would have to find an alternate route.

The topographic map in the field guide did not cover the entire area, so I had a terrible time finding the road that would take me to the southwest side of Wind Mountain, which was the reported location of the mine. This map was cut off to the north, and I could not find the entrance point to the main road. I found a parking area on the northeast side and was about to conduct an overland hike when I said the heck with it. Distances can be very deceiving in the mountains. Since Wind Mountain is like a wide, rounded cone, I was not even certain where I was with respect to the mine, and my GPS was of limited value since I did not have the topographic coverage for this area in the GPS unit. However, my limited maps indicated that a road was accessible on the southeast side. I decided to make a trip around the southeast side, get as close to Wind Mountain as I could, and then walk to the mine.

It took another half hour to drive to the southeast side. I drove as far as I dared, and finally parked my car at a side turnoff. Using my GPS, this location was 32° 01.421N, 105° 29.325W. Based on the photocopy of the topographic map in my NMBMMR field guide, I estimated my hike to the mine at about two miles. It would be quite a walk, but I would probably not get back for a long time, and I do not like to fail when I have invested significant time and money in getting to a site. I put on my boots, sunscreen and hat, threw a couple of large water bottles in my pack, and began my hike.

Fortunately, hiking overland in the foothills of Wind Mountain is relatively easy. I had to cross some wide, boulder-filled arroyos, but they were not too difficult. I did not see any rattlesnakes, which somewhat surprised me, but the heat was apparently too intense.

The rocks immediately struck me as unusual. The dominant rock type was a porphyritic syenite with large, well-aligned phenocrysts of potassium feldspar. As expected, I did not see any indications of free quartz in the rock, showing that the rock was indeed silica deficient.

I soon came around the south side of the mountain and before long I could see the mine. Fortunately, it is extremely easy to spot, as it has a large dump and a road that leads right to the mine. It was still a long hike, but at least I knew I would make it to the mine.

Although the mine is described as a "quarry" or "pit" in the NMBMMR field guide, it is more accurately described as an adit with a large dump. Two large water tanks are at the base of the mountain, and a road leads right up to the portal. I did not see any "No Trespassing" signs or indications that this was an active mining claim.

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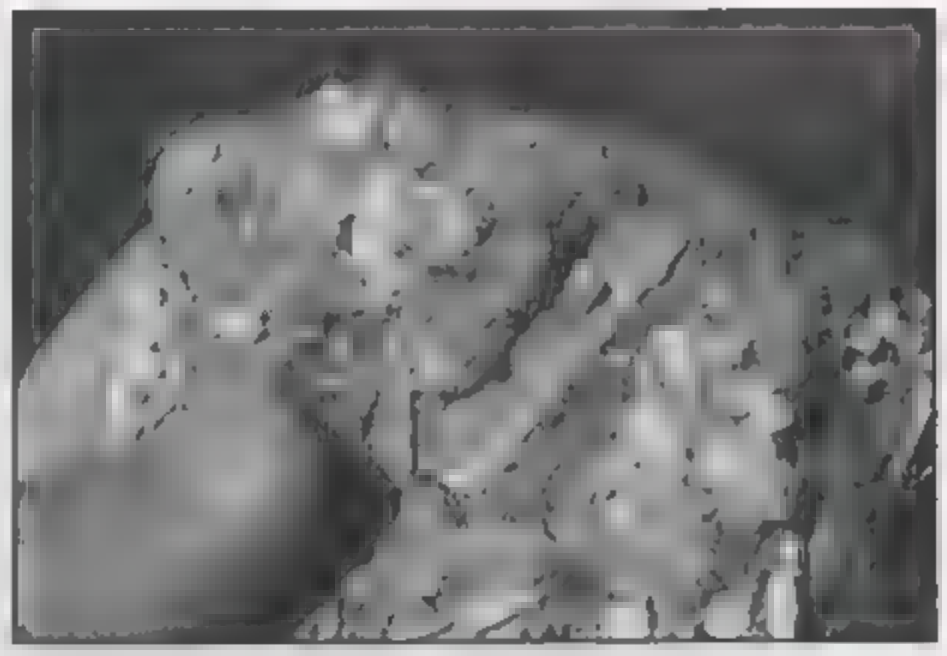
Wind Mountain Nepheline Syenite *from page 23*



Porphyritic syenites with large phenocrysts of potassium feldspar are common at the base of Wind Mountain.

I immediately noticed some very striking rocks. The first was a piece of gray intrusive rock with large black crystals. The crystals were about an inch long, narrow, and oriented roughly perpendicular to the gray intrusive. The rock was also extremely dense. I thought the black mineral was likely hornblende, given the crystal habit and the hardness of about Mohs 5 or 6.

There was an abundance of fresh rock to pick through at a small stockpile just west of the adit. The rock appeared to be a relatively uniform pile of what I assumed to be the nepheline syenite. From about 20 feet away, it appeared light gray to white. At first glance, it appeared to be granitic, but close inspection revealed that the rocks were complex masses of intergrown crystals. They were unlike any intrusive rocks I had ever seen.

I could not see any quartz in the rocks. I could pick out blades of tan minerals, which I assumed were feldspar, and there was an abundance of blated black minerals, which I assumed were hornblende. In many pieces, reddish-brown grains were intergrown between the feldspars and hornblendes. At first I thought these could be eudialyte crystals, but I was not certain.

Many of the rocks had distinct miarolitic cavities. I searched many of these for good micromounts, but I was not able to find any with good, distinct crystals. Apparently, even my near-sighted eyes could not magnify the cavities enough to see the micromounts. I found searching the stockpile for megascopic minerals much more interesting.

The adit is sealed by a gate, and I could not enter it. The bolts appeared to be fairly new, and were not rusted. However, the area likely does not get much precipitation, so this in itself made it hard to tell the age of the gate. Based on the information from when the area was explored for nepheline syenite, I guessed it was 10 to 15 years old, which is extremely young for most mines in the Southwest.

A very challenging aspect of collecting at this site is mineral identification. As mentioned, miarolitic cavities are easy to find in the rocks, but it is difficult to identify the individual minerals in the cavities. Many of the cavities did not have any prominent minerals growing into them, which made it even more difficult to identify the smaller minerals on the sides of the cavity.

An excellent feature of the rocks on the stockpile is that they are all relatively unweathered and appear unaltered by hydrothermal fluids. They have also been broken into manageable sizes for collectors. The potassium feldspar and hornblende are relatively easy to identify, but several other minerals are much tougher.

Some of the rocks have a vitreous, radiating, white mineral that resembles stilbite, but I thought it might be analcime, given that the rock was high in alkalis. I also found a mineral that is red-brown with a square cross section. I had no idea what this mineral could be. Some of the feldspars have a bladed character that suggests that they could be cleavelandite, which was not too surprising.

One of my hand samples had reddish-brown and light green anhedral minerals in between well-formed phenocrysts of light tan and gray feldspars and black hornblendes. At first, I thought the reddish-brown mineral could be eudialyte, but I was not sure. I also had no idea what the light green mineral could be, but it resembled the green of amazonite feldspar.

After searching the piles for potential eudialyte, I finally found a piece that had the characteristics I was looking for. The piece was only a couple inches long, but it was full of disseminated, reddish-brown to pink grains, which resembled the eudialyte that was present in my piece from Mont St. Hilaire.

I did not observe any pyrite or other indications of metallic minerals anywhere in the area. There were also no indications of other minerals that I typically associate with southern New Mexico, such as fluorite or agate. All the minerals that I observed were hard, at least Mohs 5 or 6, and generally had a vitreous luster. I was somewhat surprised at the amount of dark minerals, such as hornblende, in the nepheline syenite. The high proportion of dark minerals undoubtedly increased the iron content, and has likely made some of the nepheline syenite less desirable for glass manufacturing.

I could have spent hours searching the stockpile for interesting pieces, but unfortunately, my time at the site was limited. The GPS reading I took to document the mine location was N 32° 00.977', W 105° 31.388'. I did not want to hike back in the dark, as I figured the rattlesnakes and scorpions would soon be emerging. I made it back to my car shortly after the sun went down.

I thought that the way in was too long, so I decided to exit the area via Dell City. This was a big mistake. First of all, I could not find the exit road, and I wound up driving back into the mountains. However, I soon found the main road. My rental car was equipped with satellite radio, so I had crystal clear reception in the middle of nowhere, which seemed very bizarre, but it was very helpful in keeping me alert. It took much longer than I would have liked to return to El Paso, but fortunately I had filled my car with gas at the last possible stop before entering the mountains.

To get to Wind Mountain, take U.S. Highway 62/180 east from El Paso to the first major exit after Hueco Tanks State Park. This is shown as County Road E1 on the New *Mexico Road and Recreation Atlas*. Follow this to County Road E18, which later turns into E17. Although they are marked like this on this map, I do not recall these roads being labeled in the field. Roads in remote areas are often not marked as well as we would like. However, once you are in the area, you can follow your topographic maps to get to Wind Mountain, which is very distinct and easy to identify. I wish I could provide better written directions, but based on previous route logs and maps, the access and road conditions appear to change fairly frequently. The best bet for a successful trip is to bring original topographic maps and a GPS unit when exploring this site.

Wind Mountain is a fascinating place for advanced collectors and those who like out-of-the-way sites. Due to the hiking involved, the access route I used is not good for small kids or folks who cannot walk far. If one can find the access road to the mine, it is a fine place to bring families, as there are no shafts or dangerous highwalls that I saw, but your family had better be able to appreciate long drives and remote places. The miners certainly had to bring in their equipment, so I am sure that with some additional effort, one will be able to find the correct access road.

LAPIDARY LORE AND MORE

America's Rich Gem Heritage

by June Culp Zeitner

Most rockhounds are familiar with the gems of Africa, Australia, Brazil, and India, but how many can name more than a few fine gems primarily associated with America? Several excellent gems have been found in America, some were named for an American or have been found to be unique to America. George Frederick Kunz, the Tavernier of America, found some exquisite pink beryl, which he named *morganite* for the industrial leader John Pierpont Morgan. This all-American gem is found mostly in California.

J.A. Stevenson appointed some green and lavender rose gems to William Hidden. The green was ultimately named *hiddenite* and the lavender rose called *kunzite*. Another great gem, a rose red garnet, was named *rhodolite* for its resemblance to the delightful flowering shrub covering the Smoky Mountains in the spring.

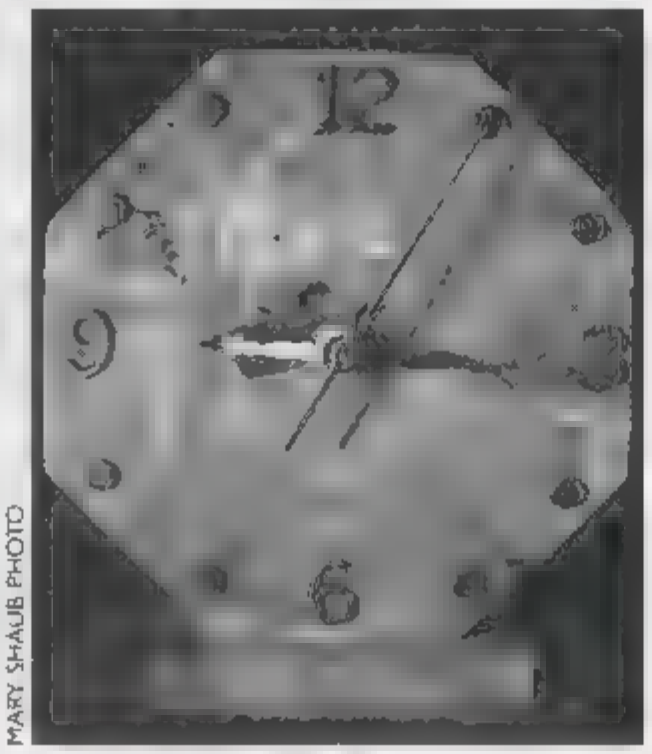
A unique American fine gem was discovered in San Benito County, California. *Benitoite*, a dichroic gem, has lovely blue colors and a rare crystallization. The unusual stones only occur in this one locality.

Franklinite is only one of several fluorescent minerals at Franklin and Ogdensburg, New Jersey. The lapidary gem *rhodonite* is also found there.

Amethyst is a popular gem worldwide, and America has its share. Good locations are in Arizona, Georgia, South Carolina, North Carolina, and Virginia. America is particularly rich in the quartz gems, both crystalline and cryptocrystalline. *Rose quartz* is found in many mines in South Dakota. Excellent *smoky quartz* is accompanied by *amazonite* in Colorado. Splendid *agates* are found in Minnesota, South Dakota, Montana, Wyoming, Oregon, and California.

Turquoise is the symbol of the Southwest, with Nevada as the leading source and Arizona and California not far behind. A second phosphate is *variscite*. Utah is proud of this blue-green gem. The nodules that came from Fairfield are among the most beautiful gems ever found.

One only has to look at one California gem to realize it is rare and expensive: transparent *crystalline quartz* ornamented with graceful patterns of pure gold.



MARY SHAUB PHOTO

Massachusetts rhodonite is just one of many American gemstones.

Jade, mostly *nephrite*, is found in Wyoming, California and Alaska. California alone has some *jadeite*. The readily available nephrite is a great favorite with gem carvers.

One glamorous gem is *chrysocolla*. Unfortunately, a very inferior stone has been called by the same name. The poor material is a brittle mixture of off-color malachite, azurite and chert. The real gem is top quality, flawless, translucent chalcedony with a lovely blue color and a Mohs hardness near 7.

A gem *scolite* is interesting. From Minnesota's North Shore come small, attractive, marblelike nodules of *thomsonite*. They have showy eyes in tones of olive green, emerald green, pink, and cerise, fuschia, poppy, and azalea. A soft muted green variety was named *lutomite* after a woman.

Tourmaline is one of the most desirable of gems. Choice colors are reds and greens, and favored localities are Maine and California.

Rose quartz is a product of Georgia, California, Colorado, Arizona, and Virginia, with the Scott Mine in Custer, South Dakota, surpassing all of these. Some of the Scott Mine material is chatoyant and will cut into amazing stones.

The iron mines of Minnesota produce *hinganite*. America's answer to Africa's tiger's-eye. In hinghamite (not an accepted name), iron minerals provide the chatoyance rather than crocidolite, as in tiger's-eye.

Vivid green *malachite* and sky blue *azurite* from Bisbee, Arizona, and other copper mines occur separately or together. Marble-size azurite nodules called "blueberries" are desirable to lapidaries.

Facet-quality *rhodochrosite* comes from Colorado. A third gem starting with "rhodo-," for "rose," is *rhodonite* from Massachusetts, California and Oregon.

Sunstone from Oregon is a true American gem, an aventurescent labradorite, a bright feldspar of yellow, yellow-orange and orange. There is also *moonstone*, another feldspar, with silver or blue adularescence against pastel tints.

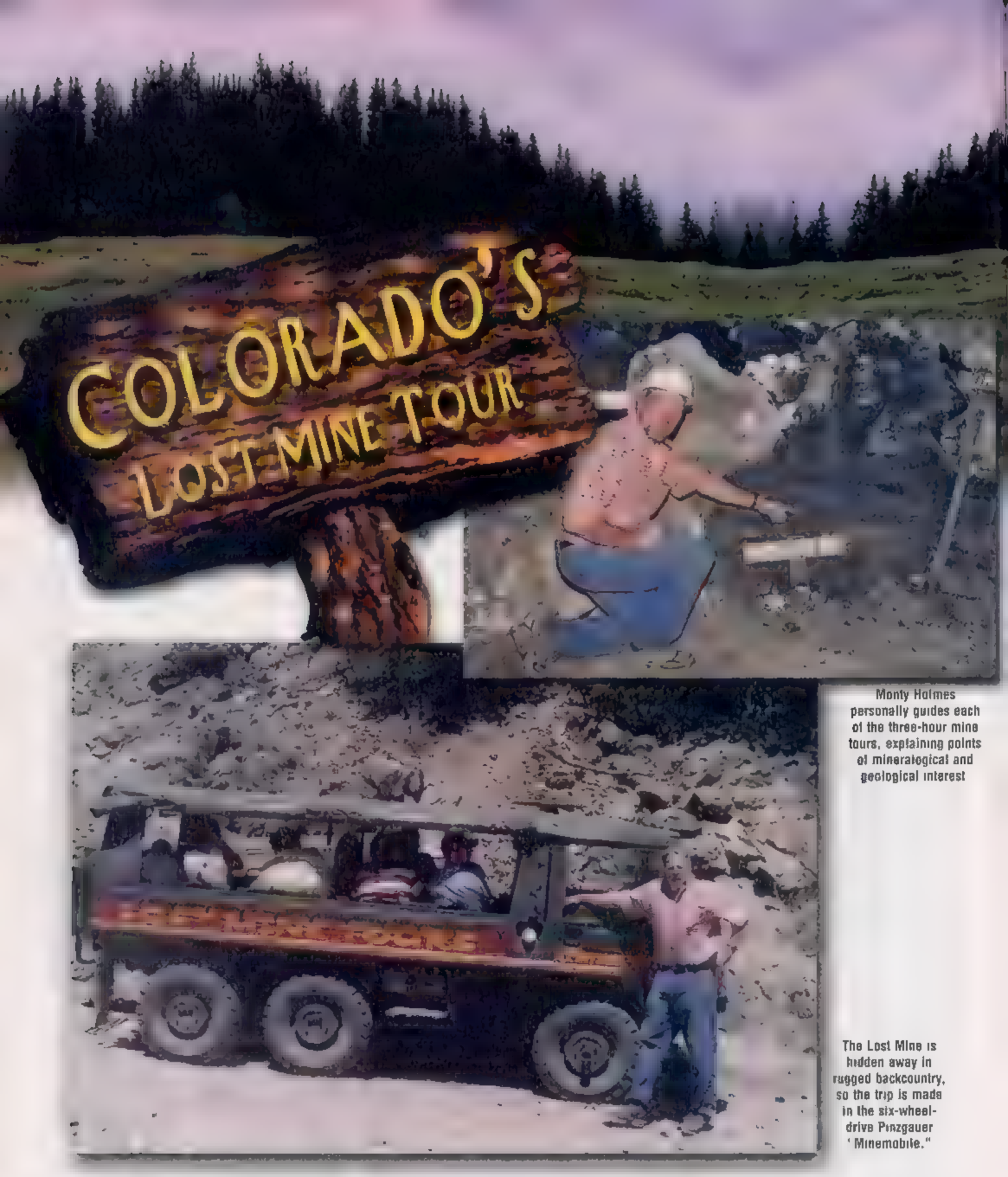
We usually associate *opal* with Australia, but some of the most colorful opal comes from the United States and Canada. Black opal from Nevada is one of the showiest. It is opalized wood with a gorgeous play of color. Oregon has vibrant contra luz opal and Idaho has the Spencer Opal Mine. Even Louisiana joins the opal parade with tiny dots of brilliant color in a porous matrix.

Topaz is claimed by two states, Texas and Utah. The Texas topaz (the state stone) is a subtle blue, many of the intense blues are irradiated or heat treated. The sherry tinted Utah crystals are sometimes treated, too. New Hampshire and South Carolina are other states with topaz.

Peridot, the August birthstone, is thriving in Arizona, where the small, yellow-green stones are mined in quantity on the San Carlos Indian Reservation. Volcanic rock on New Mexico's border with Mexico is also decorated with these cheerful yellow-green stones.

We have *garnets* galore. Almandine, dark red and shiny, is lavishly sprinkled over the schists of the Black Hills. Star garnet is Idaho's state stone. Orange spessartine garnets brighten mines at Amelia, Virginia. I once searched for kimzeyite garnets at Magnet Cave, Arkansas.

I've mentioned more than 30 U.S. gems that compare favorably with the beautiful stones from other countries. There are at least another 20 that I didn't list. Altogether, we have a great gem heritage. ✧



Monty Holmes personally guides each of the three-hour mine tours, explaining points of mineralogical and geological interest

The Lost Mine is hidden away in rugged backcountry, so the trip is made in the six-wheel-drive Pinzgauer 'Minemobile."

A Manganese Mine Opens to the Public

Story and Photos by Steve Voynick

Thanks to the rapid growth in cultural tourism that emphasizes regional historical attractions and activities, "tourist mines" are riding a wave of popularity. Across the United States, some 50 mines now pay their way not by extracting and shipping ores, but by offering tours to the public. Most are former gold mines, which is not surprising considering the yellow metal's appeal, romance, and rich history. But to a lesser extent, mines that once produced silver, copper, lead, and coal also serve as tourist mines.

And now, one of the nation's newest tourist mines, the Lost Mine, near Salida in central Colorado, showcases a less-familiar mineral commodity: manganese. The Lost Mine may be the only underground manganese mine ever to re-open as a tourist attraction.

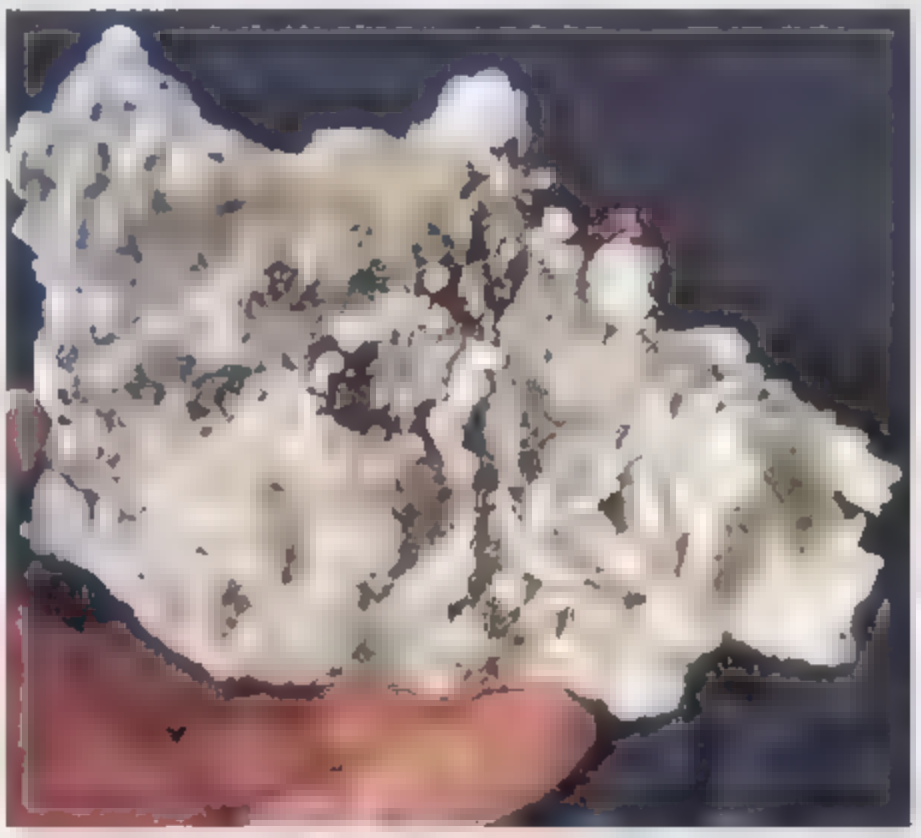
But manganese is not all that sets the Lost Mine apart. Unlike most tourist mines that visitors can drive to directly, the Lost Mine is hidden away in rugged backcountry, getting there is an adventure in itself. Furthermore, the Lost Mine, which operated only during World War I, represents an obscure period in American mining history, one that falls between the precious-metal mining of frontier times and the modern mining era.

The story of the Lost Mine begins with manganese itself. Manganese oxides and oxyhydroxides, the Lost Mine's ore minerals, have been used as black pigments since antiquity. But because manganese, a silvery-white, brittle metal about as dense as iron, does not occur in native form, it was not isolated and identified as an element until 1774. The first important modern use of manganese compounds came in the 1860s with the development of the dry-cell, carbon-cathode battery (the modern flashlight battery). Manganese dioxide is a vital component of the electrolytic paste that separates the battery's carbon cathode from its zinc-cased anode.

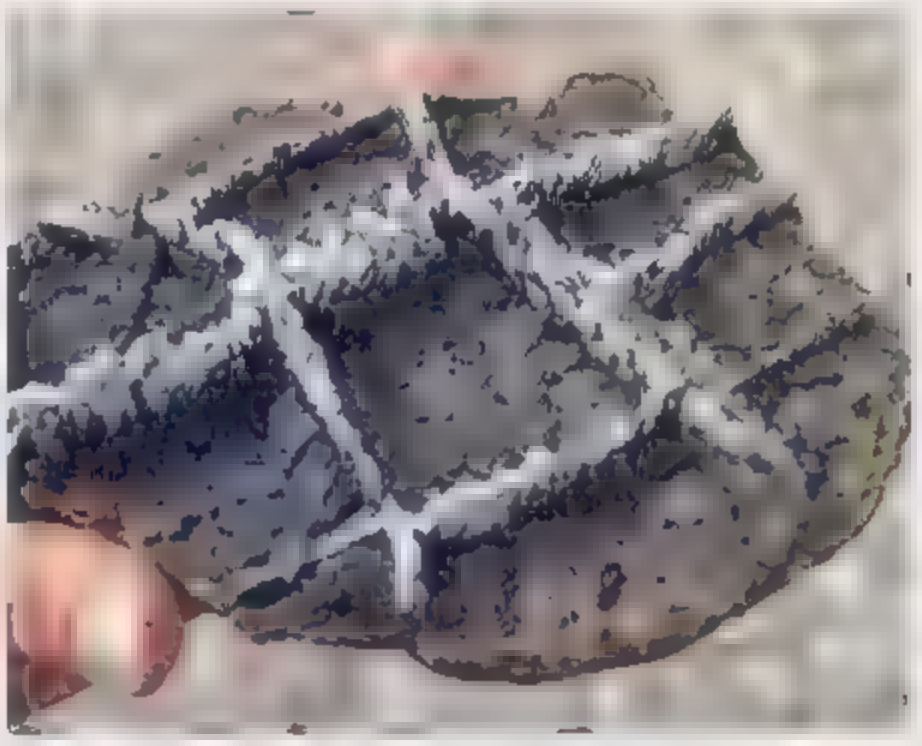
Nineteenth-century researchers also learned that manganese was an excellent flux for deoxidizing iron and steel in reduction processes. And by 1900, metallurgists had found that adding manganese to steel created a tough alloy with great resistance to mechanical wear.

Despite these developments, however, industrial demand for manganese and other alloying metals such as tungsten and molybdenum remained limited, and commensurately low prices gave prospectors and exploration geologists little reason to search for the metals.

But this all changed abruptly in 1914 with the outbreak of World War I. Soaring demand for hard, durable steel alloys for weaponry and armor and for the tool steels needed for their fabrication quickly drove the prices of manganese and other alloying metals to record levels. As manganese prices quadrupled, prospectors once concerned only with gold and silver now began searching for deposits of this formerly obscure alloying metal.



Calcite is one of the most common minerals associated with the Lost Mine manganese deposits.



This unusual growth of calcite formed in cracks in a layer of pyrolusite, which later disintegrated.

Among them was W.H. Boyer, who supervised a lime-kiln operation near the railroad stop of Wellsville, six miles east of Salida. In his spare time, Boyer prospected the interbedded strata of sandstone, shale, limestone, and travertine that were exposed in the nearby ridges and canyons. His efforts were rewarded in January 1916, when he discovered an outcrop of pyrolusite, psilomelane and wad.

Pyrolusite, or manganese dioxide, the primary ore of manganese and the most common manganese mineral, occurs in black or dark bluish-gray powdery, granular and fibrous masses and as dendritic crusts. Psilomelane, a complex barium manganese oxyhydroxide of variable composition (and thus not a valid mineral species), is a lesser ore of manganese. It is black, earthy and brittle, and forms fine-grained, botryoidal crusts, stalactites, and cavity fillings. Wad, a generic term, refers to a variable mixture of oxides and hydroxides of manganese and barium. Pyrolusite is a secondary mineral that, along with psilomelane and wad, sometimes forms replacement deposits in limestone.

What Boyer had discovered was an outcrop of a replacement deposit in which pyrolusite, psilomelane, wad, calcite, and dolomite had replaced a limestone bed. His shallow open cut revealed the approximate size of the deposit and the fact that it dipped at an angle of roughly 45 degrees. After assays indicated that the pyrolusite contained 40 percent manganese by weight, Boyer immediately staked two lode claims.

Boyer brought samples and assay reports to the Colorado Fuel & Iron (CF&I) steel mill at Pueblo, 90 miles to the east. Metallurgical tests showed that the pyrolusite could be used directly, that is, without any prior milling, concentration or refining, as both a deoxidizing flux and as a source of alloying manganese. The steel company offered Boyer a contract to purchase at the going market price all the hand-cobbed pyrolusite ore he could provide.

After some exploratory tunneling, Boyer estimated that some 5,000 tons of pyrolusite ore were waiting to be mined. He hired a few local miners to construct a portal at a lower point on the hillside and began driving a haulage tunnel to intersect the deposit. The reasonably stable rock required only minimal timbering for ground support. And by driving the haulage drift beneath the dipping ore bed, miners could extract ore from overhead stopes. In this simple, inexpensive mining approach, the ore would fall by gravity to the haulage level to be loaded into small ore cars.

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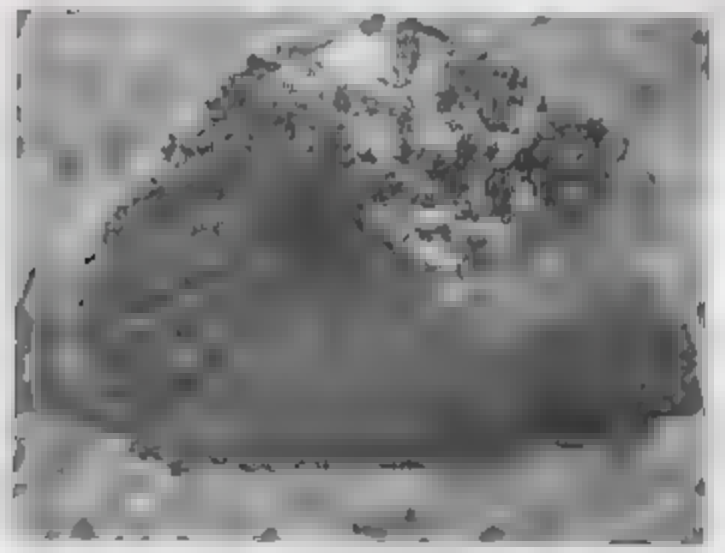


This specimen of Lost Mine ore consists of delicate botryoidal psilomelane decorated with a white calcite crust

With miners using only hammers and hand steels for drilling, mine development proceeded slowly. But that was no concern for Boyer. A few months later, he accepted a $25,000 offer for his claims and made a profitable exit from the manganese-mining business.

As the new owners continued to develop the mine, they also conducted additional assays which revealed that some pyrolusite ore contained as much as 3 percent tungsten. Tungsten, which increases both hardness and thermal resistance of steel alloys, is rarer than manganese and much more valuable, especially since wartime demand had increased its price tenfold. That made a single ton of the best ore, which contained 40 percent manganese and 3 percent tungsten, worth about $350. It also sent prospectors on a lively, albeit nonproductive, tungsten "rush" into the nearby hills.

The mine made its first small shipment in 1916. After extracting ore from a single stope, miners hand cobbed it at the portal, an easy job because pyrolusite's distinctive black color readily distinguished it from gangue rock. After screening and sacking the ore, they loaded it into a wooden sled inside a makeshift declined conveyor, a long enclosed metal chute that led to a lower loading tipple fashioned from rough logs. From there, mule-drawn wagons hauled the ore two miles to the railroad at Wellsville for shipment to the CF&I steel mill.

The mine made another shipment of ore, this time 40 tons, in 1917. But during its brief operating life, the mine shipped only a total of 80 tons of ore. Plans for higher production were cut short when World War I came to an end with the Armistice of November 11, 1918. Almost overnight, demand for alloying metals fell flat. Prices for manganese and tungsten plummeted, and the mine closed in early 1919.

During the following decades, only a few backcountry hikers visited the mine. Even its location became confused when a realignment of the nearby county line moved it from Fremont County into Chaffee County. Since Fremont County had "lost" the mine, it became known among local residents as the Lost Mine.

The mine remained largely forgotten until just a few years ago, when Salida rockhound and builder developer Monty Holmes began looking for backcountry property for a cabin site. He came across the old mine and conducted an initial underground exploration using light from improvised sagebrush torches.

"I returned later with better lighting and found an ore car, haulage rail, some blasting materials, and even some old ceramic whiskey jugs that the miners had left behind," Holmes recalls. "There were three interior drifts, two tunnels, and a stope about 150 feet of underground workings along with some well-preserved square-set timbering. After researching the history and geology, I bought the property and started thinking about turning the mine into a tourist attraction."

But first, Holmes had to do a lot of work.

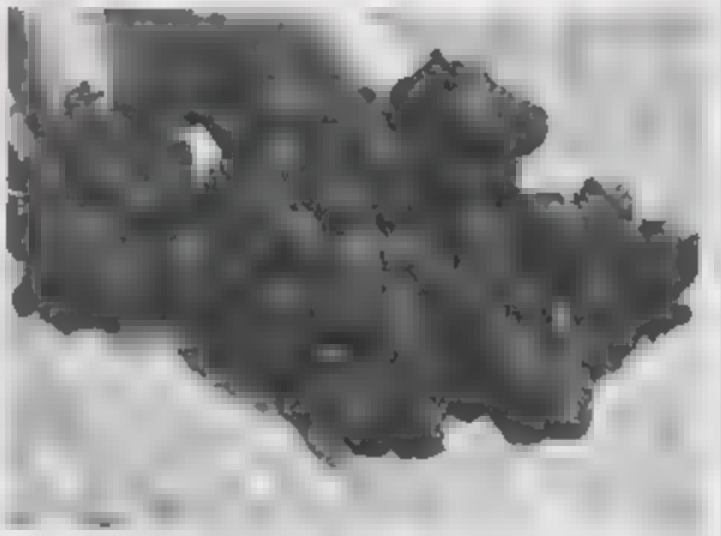
"The mine had been inactive for 85 years, and much rock had sloughed off the ribs and the back," Holmes explains. "In places it was 3 feet deep, and it all had to be removed."

Holmes hired three retired miners from a pair of well-known Colorado mines, the Climax molybdenum mine and ASARCO's Black Cloud Mine, both about 50 miles north of Salida, near Leadville. They cleaned out the waste rock, checked the timbering, installed a few timber stulls for additional ground-support safety, and rigged an underground lighting system.

"When things were ready, I requested an inspection by the Colorado Division of Mines," Holmes recalls. "A state inspector checked everything from oxygen levels to rock stability and approved the mine for public tours."

Because the mine is inaccessible by highway vehicles, Holmes needed one more thing: a reliable, rugged, and roomy vehicle capable of transporting more than a dozen visitors at a time to the mine. His choice was a Pinzgauer, a 14-passenger truck manufactured in Austria by Steyr Daimler Puch for several European military forces. This rugged, six-wheel-drive vehicle would prove ideal on the rough Lost Mine tour route, where one backcountry grade actually measures a rollercoasterlike 50 degrees.

The Lost Mine tour begins in Salida, where visitors board the Pinzgauer "Minemobile" for a six-mile journey east



Psilomelane is a complex barium manganese oxyhydroxide of variable composition, and therefore not a valid mineral species

along U.S. Highway 50, past the Wellsville Fold and adjacent geological faults, and into the Arkansas River canyon. At Wellsville, the tour turns off onto dirt roads that lead to its first stop: the lime quarry and kilns that Boyer supervised at the time he made his manganese discovery in 1916.

Nestled near the base of a colorful, iron-stained limestone cliff, the kilns, which date to 1895, originally had circular brick walls 25 feet high, with spaced holes for regulating the draft and bottom gates for removing finished lime. Quarrymen blasted limestone from the cliff, crushed it into fist-sized chunks, then loaded it into the kilns, alternating layers of limestone (primarily calcium carbonate) with layers of piñon-wood fuel.

In a calcining reaction, heat broke down the calcium carbonate molecules, driving off carbon dioxide to leave behind calcium oxide, or lime (quicklime). The addition of water converted the quicklime to calcium hydroxide (caustic lime). In the early 1900s, quicklime and caustic lime found use in everything from plaster, mortar, stucco, and whitewash to septic treatments and soil conditioners. The quarry and the kilns operated until 1935, when mass-produced cement mortar largely replaced lime mortar.

Back in the Minemobile, Holmes explains points of geological and mineralogical interest, including several visible geologic faults. As an example of fault-zone rock, Holmes passes around a superb specimen of "slickensides," a rock which fault movement had naturally polished to smoothness and luster. When the Minemobile nears an old quarry that produced travertine, a massive, layered calcium carbonate (aragonite or calcite) rock of hot-springs origin widely used as a building stone, it passes around a gleaming slab of cut and polished pink travertine.

continued on page 32

Colorado's Lost Mine Tour *from page 10*

The last mile of the trip is fairly steep and ends at the Lost Mine itself, elevation 7,700 feet. As visitors enjoy the view to the south that takes in the Sangre de Cristo Mountains and 14,345-foot-high Blanca Peak 70 miles distant, Holmes fires up the portable generator that powers his underground lighting system.

Leading his tour group along the 50-yard long path to the mine portal, Holmes points out W. H. Boyer's original, 90-year-old discovery cut. At the mine portal, he displays a collection of pyrolusite and psilomelane specimens, most associated with white calcite and dolomite in a variety of interesting habits. While visitors examine the specimens, Holmes enters the mine alone to measure oxygen levels, check the electric lighting, and to look for any potential safety hazards.

After providing everyone with a flashlight and a required hardhat, Holmes leads the way into the mine, pausing at the original square-set timbering to answer questions about ground support. He then continues on to a spacious, open area beneath a high stope, where the rock walls show a massive, jet-black vein of pyrolusite and psilomelane decorated with snow-white crusts of calcite and dolomite. Holmes describes how miners extracted ore from the overhead stope using hand drilling methods, then loaded it into ore cars for hand tramming to the portal.

Because visitors are literally standing in the middle of the manganese deposit, Holmes' explanation of its genesis is easy to visualize. The surrounding country rock is of marine origin with alternating beds of sandstone, shale, and 300 million-year-old late Paleozoic limestone. Later, hot solutions would dissolve manganese minerals from adjacent formations, transporting them to a section of the limestone bedding that served as a solution trap.

After the solutions dissolved away parts of the limestone, manganese minerals precipitated out of solution and filled the resulting voids. Secondary calcareous solutions then circulated through the manganese mineralization to deposit calcite and dolomite. The manganese deposits irregularly follow the original limestone bedding, pinching and swelling in places to create massive ore pockets.

Holmes explains that the ore consists mainly of pyrolusite and psilomelane, with lesser amounts of wad and manganite (manganese oxyhydroxide). In places, the ore body is crystalline and fibrous, with numerous cavities containing botryoidal psilomelane. The cavity walls often consist of alternating bands of compact

Holmes explains the limestone quarrying operation that produced the raw material for the production of quicklime

psilomelane and fibrous, crystalline pyrolusite. Also apparent are many rodlike growths and concretions with hard outer shells of psilomelane encasing pyrolusite.

Holmes then treats everyone to a display of underground color. Cutting the lights and plunging the mine into darkness, he demonstrates with both long-wave and short-wave ultraviolet lamps how mineral impurities create a white and green fluorescence in some of the calcite and dolomite.

When the underground tour concludes, visitors board the Minemobile for the return trip to Salida. Salida is 90 miles west of the city of Pueblo via U.S. Highway 50 and 140 miles southwest of Denver via U.S. Highway 285. The Lost Mine tour departs from the Country Bounty, one of Salida's most popular restaurants, on U.S. Highway 50. From May through October, tours leave daily at 10 a.m. and 2 p.m. Monty Holmes personally guides each of the three-hour tours. Walk-ins are welcome, space permitting, but reservations are always recommended. From November through April, tours must be arranged in advance. The cost of the tour is $39 for adults and $29 for children ages 12 and under, and includes transportation in the Pinzgauer Minemobile.

Because of the relatively high mine elevation (7,700 feet) and rugged terrain, visitors should be in good physical condition and wear sturdy hiking shoes. Even in summer, light jackets are recommended for comfort, as the interior mine temperature hovers at about 50 degrees F year 'round.

For reservations or further information, call (719) 221-MINE (6463) or visit the Web site www.salida.com/lostmine.

GOLD AND GEM HIGHWAYS

ROADSIDE PANNING SITES IN CALIFORNIA

Part VIII: Sixteen Spots in Five Counties

Story and Maps
by David and Clois Walker

SAN DIEGO COUNTY
(Maps CA66-68)
SITE 1. **San Luis Rey River/state Route 76** crossing near **Bonsall.**
Vicinity finds indicate aquamarine potential

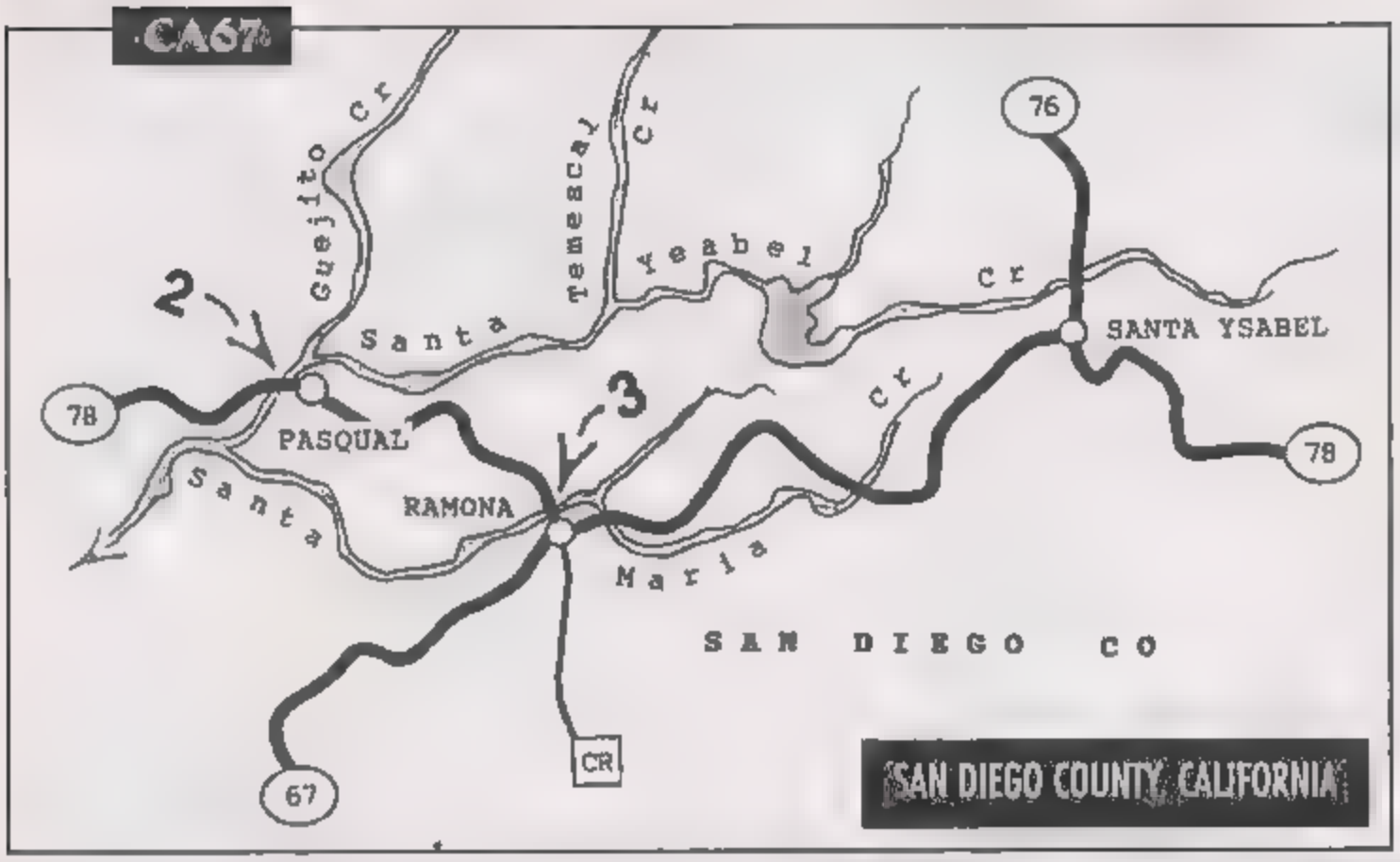
This is the eighth in a series of 10 articles containing county-by-county maps of suggested panning and screening sites at highway/stream crossings where appreciable finds have been previously reported on upstream watersheds. The principles of erosion make it likely that minerals and gemstones have been deposited in river gravels, awaiting removal by a rockhound with a pan.

The idea behind this study is that the locations will be easy to reach, without tramping over hill and dale. It also assumes that the highway crossings are government property and there will be no need to locate and get permission from property owners. However, readers run the risk of prosecution if they cross onto private land, however inadvertently. To find out where highway rights of way begin and end, contact Barry Cowen at the Right of Way Division of the California Department of Transportation (Caltrans) at (916) 654-5075 *before* you visit these sites.

Remember, too, that the government to which these rights of way belong has some regulations of its own. Be sure to observe the usual safety and environmental standards if you want to collect without a hassle.

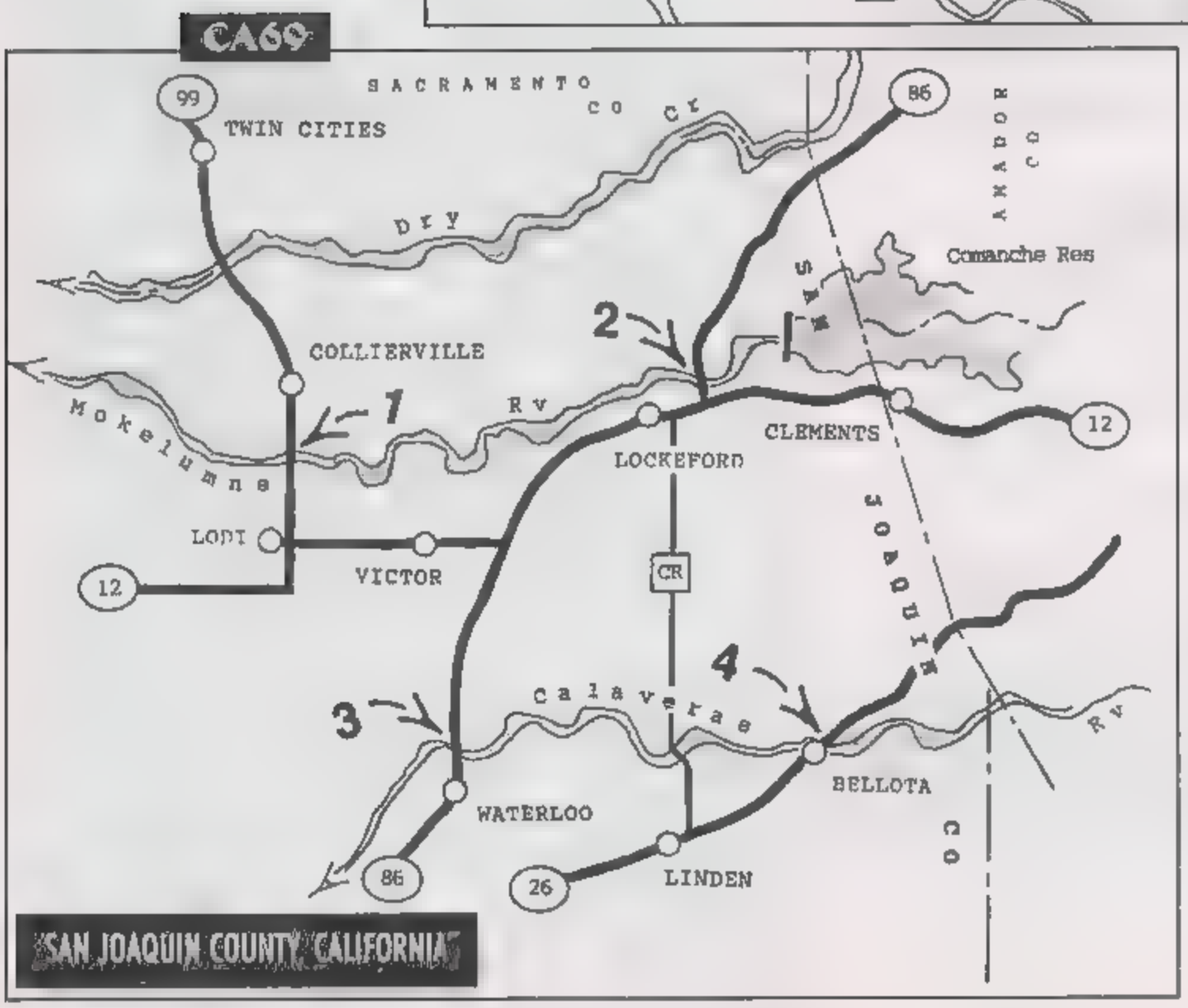
The maps provided contain the most up-to-date information available to us, but it is advisable to consult a current state highway map when planning an outing, for overall orientation in the field and because highway designations have been known to change.

So good luck! While we can't guarantee you'll hit the jackpot, we can almost assure an enjoyable outing.



SITE 2. **Guejito Creek/state Route 78** crossing, near **Pasqual.** Vicinity finds indicate gold potential
SITE 3 **Santa Maria Creek/state Route 78** crossing, near **Ramona.** Vicinity finds include aquamarine, garnet, gold, quartz crystals, and tourmaline.

SITE 4 **San Felipe Creek/ County Road** crossing, near **Borrego Springs.** Vicinity finds include gold and rhodonite.



SAN JOAQUIN COUNTY
(Map CA69)
SITE 1 **Mokelumne River/state Route 99** crossing, near **Collierville.** Vicinity finds indicate gold potential
SITE 2 **Mokelumne River/state Route 86** crossing, near **Lockeford.** Vicinity finds indicate gold potential
SITE 3 **Calaveras River/state Route 86** crossing near **Waterloo.** Vicinity finds indicate gold potential
SITE 4 **Calaveras River/state Route 26** crossing, near **Bellota.** Vicinity finds indicate gold potential

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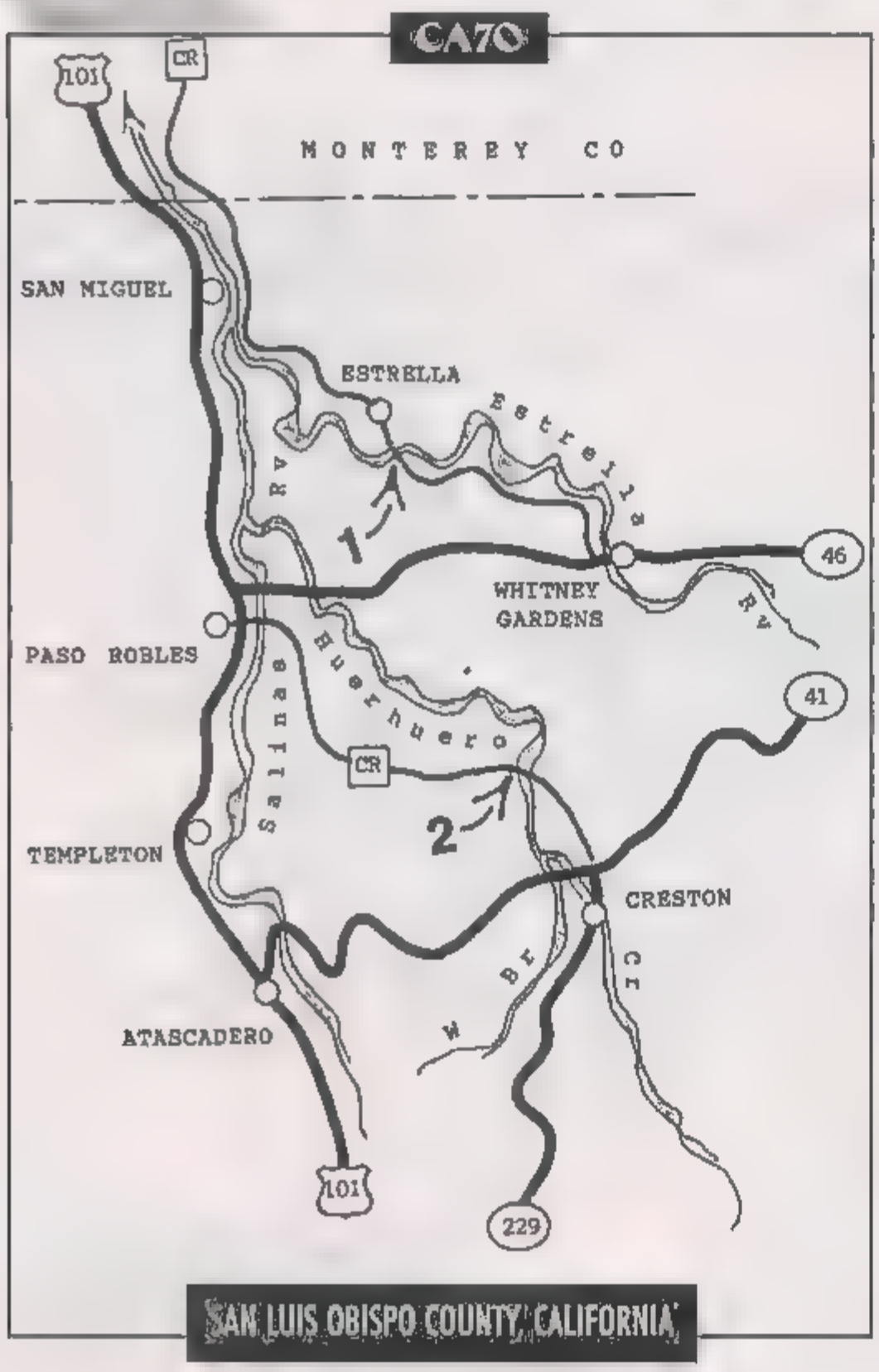

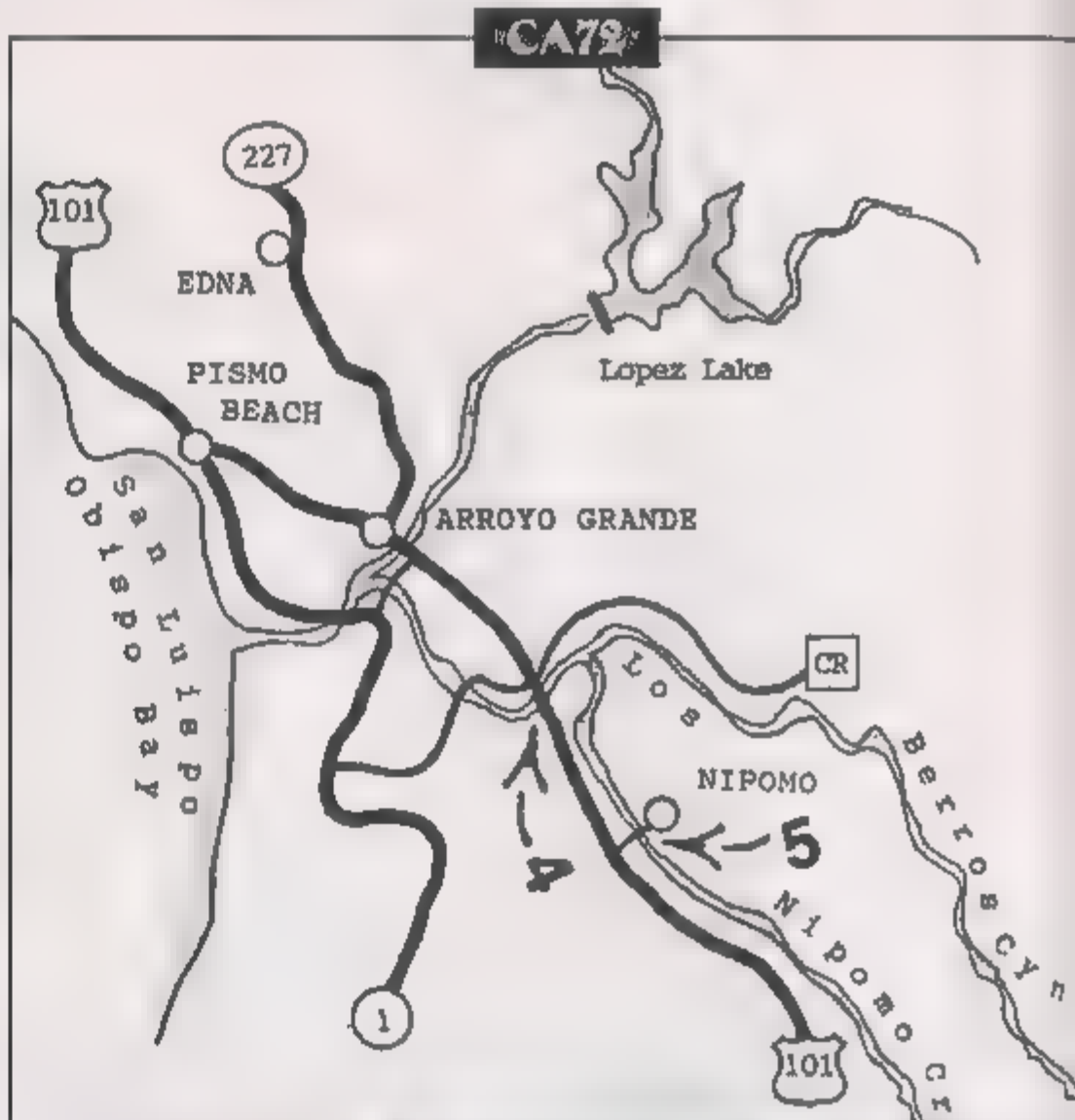

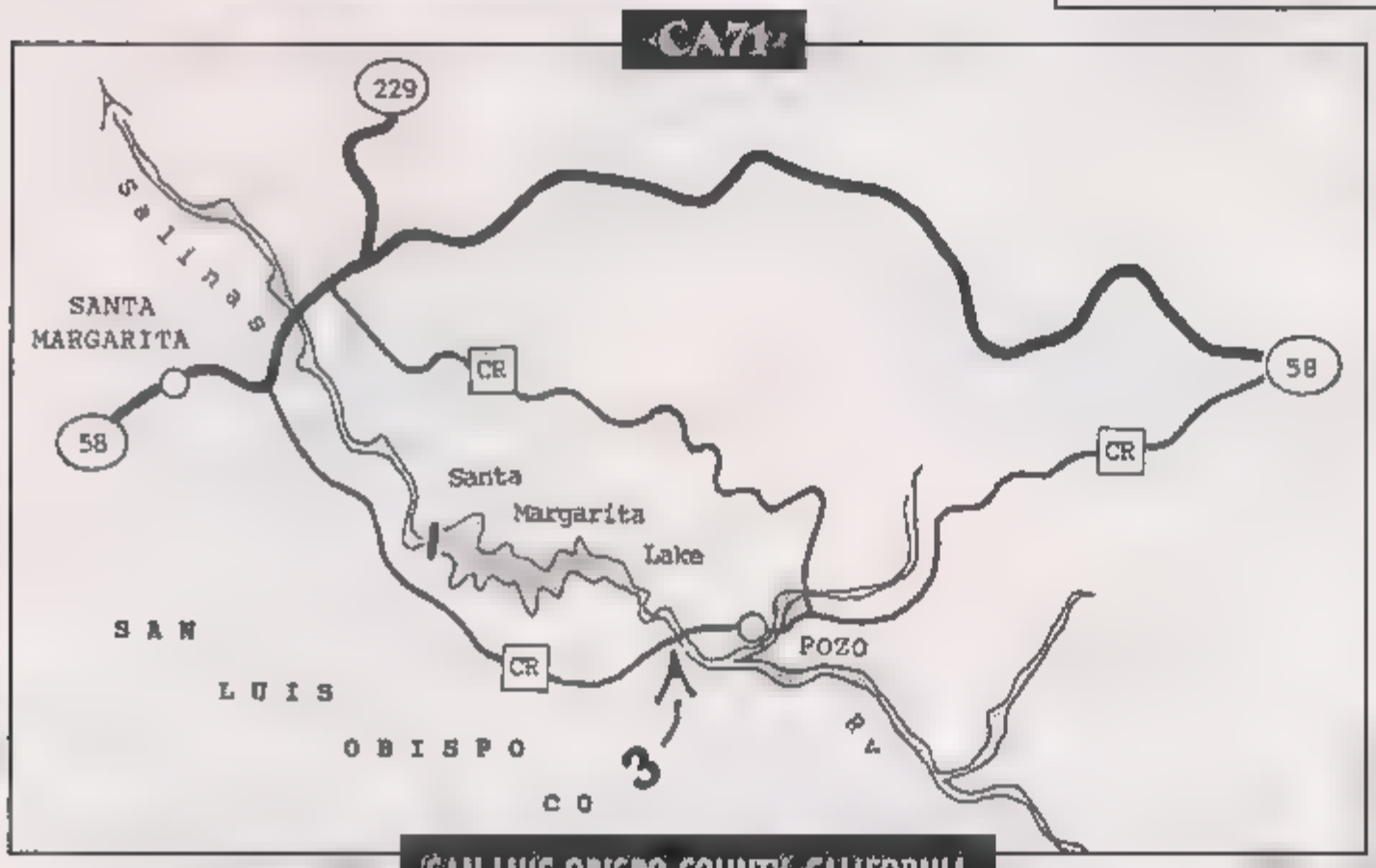

SAN LUIS OBISPO COUNTY
(Maps CA70-72)

SITE 1. **Estrella River/County Road** crossing near **Estrella.** Vicinity finds indicate jasper potential.

SITE 2. **Huerhuero Creek/County Road** crossing, near **Creston.** Vicinity finds include jade jasper and onyx

SITE 3. **Salinas River/County Road** crossing, near **Pozo.** Vicinity finds indicate onyx potential

SITE 4. **Nipomo Creek/U.S. Highway 101** crossing, near **Nipomo.** Vicinity finds include agate, jasper, and silicified wood

SITE 5. **Nipomo Creek/County Road** crossing, near **Nipomo.** Vicinity finds include agate, chalcedony, jasper, and silicified wood

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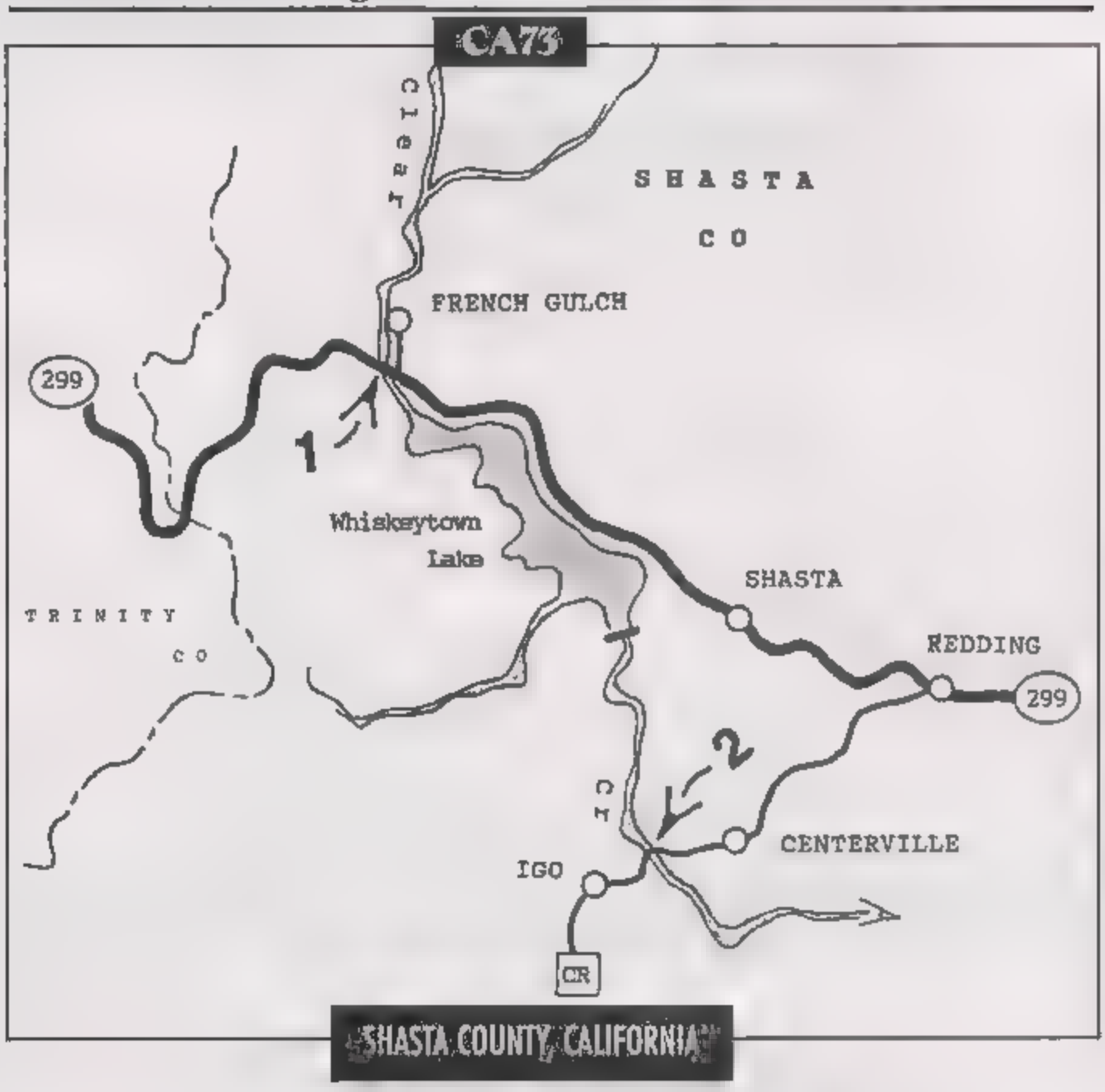
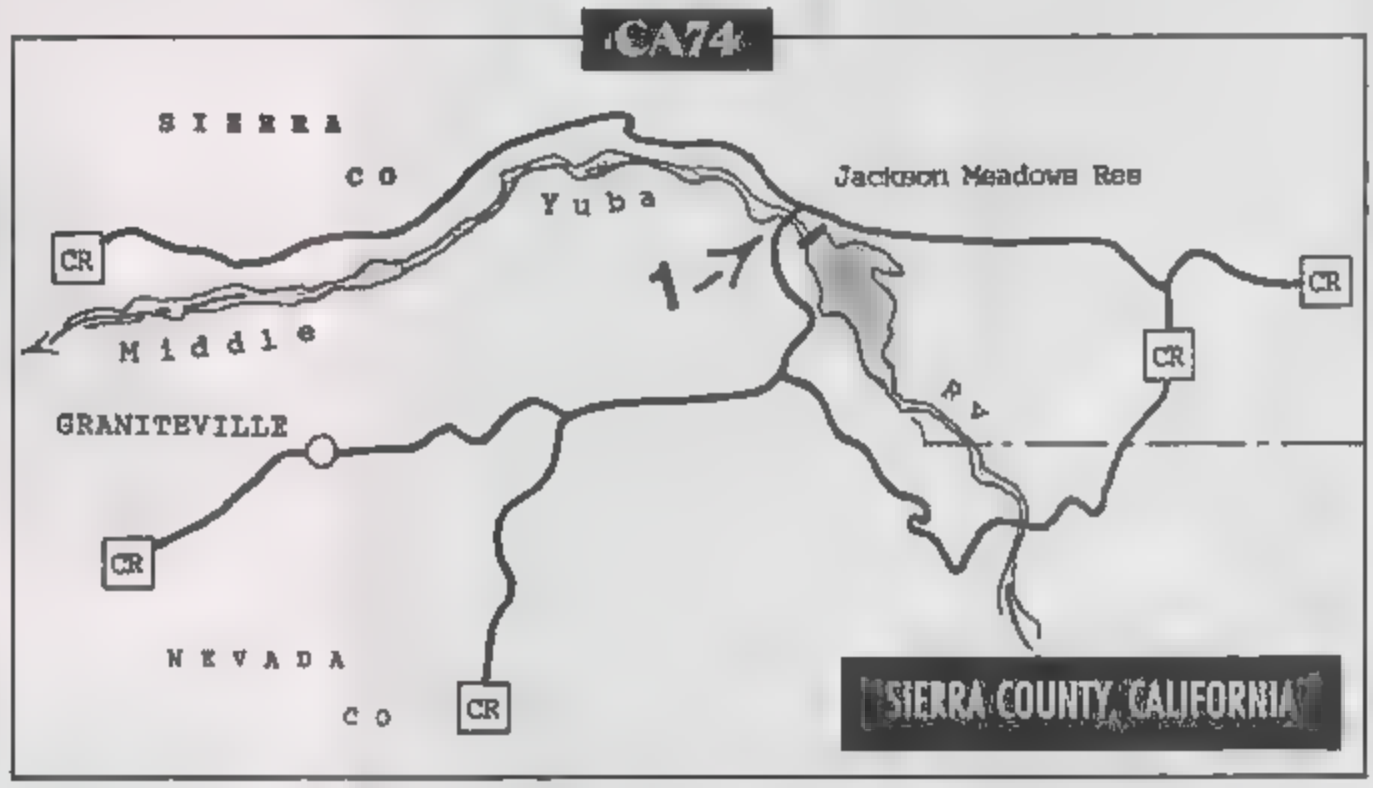
Roadside Panning Sites in California *from page 36*



SHASTA COUNTY (Map CA73)

SITE 1 **Clear Creek/state Route 299** crossing, near **French Gulch.** Vicinity finds include agate, gold, jasper, and quartz crystals.

SITE 2 **Clear Creek/County Road** crossing, near **Centerville.** Vicinity finds indicate gold potential



SIERRA COUNTY (Map CA74)

SITE 1 **Middle Yuba River/County Road** crossing near **Graniteville.** Vicinity finds indicate gold potential

The official state highway map is suggested in conjunction with these maps for overall orientation in the field.

Rock Science

Steve Voynick

Faden, Gwindel and Floaters

"Scepters, faden, Gwindel, and floaters" may sound like a line out of *Harry Potter* but each of these terms helps explain why quartz crystals, despite their abundance, never fail to fascinate. Few other mineral crystals have quartz's broad range of varieties and forms, of which scepters are among the most interesting.

Scepter crystals have distinctive, easily recognizable shapes, usually consisting of a thinner base, or "stem," that is overgrown by a larger crystal. The name "scepter" derives from its shape, which is similar to that of the ceremonial scepters of European royalty. In the "reverse-scepter" crystal form, a thicker base is capped by a thinner, terminated crystal.

Scepters are a product of geological and mineralogical conditions that existed and changed as the crystals developed. To understand scepter development, consider first the basic process of crystallization, which begins when a minute crystal, called a "seed" crystal, forms from solution. Crystals grow as seed crystals accumulate more of the same mineral constituent from their fluid environment.

In the case of quartz, continued cooling of silica-rich fluids precipitates more silica out of solution, which forms new silica tetrahedra on the growing crystal lattices. Given slow cooling, room for unrestricted growth, and a steady supply of mineral-nutrient fluids, the growing quartz crystals usually adhere closely in shape to their basic hexagonal crystal form.

But varying conditions can distort or restrict crystal growth to create scepters and other unusual crystal forms. Quartz scepters begin growing as normal quartz crystals, but before growth is completed, the mineral environment changes dramatically. Such changes are often caused by the effects of nearby volcanism, igneous intrusions, or fault movements, which can alter temperature, pressure, or the mineral-nutrient mix of fluids within a given mineralogical environment, or can even cause the partial or complete withdrawal of hydrothermal fluids.

In a quartz-crystal environment, fluid withdrawal will leave behind voids containing common prismatic quartz crystals. But should hydrothermal fluids later resurge into these crystal-lined voids, the existing quartz crystals can act as seeds for second-phase crystallization. New crystals begin forming atop the original crystals, usually directly on the termination faces. Over extended periods of secondary growth, the new "tip" crystals may become larger than the original stem crystals, creating what are called "positive scepters." But if the period of secondary crystallization is relatively short, the new tip crystals will be smaller than the stem crystals, creating "reverse scepters," or "negative scepters."

Because the secondary hydrothermal fluids differ in mineral composition from the original fluids, scepter crystals sometimes consist of two distinct quartz varieties. Typical "combination" scepters, which make eminently collectible specimens, can include amethyst tips on colorless rock crystal stems or smoky quartz tips on milky quartz stems. Of all minerals, quartz provides the best examples of scepter development.

Another unusual type of quartz is known as faden (pronounced FAH-den) quartz, which is characterized by a milky-white leathery or fibrous zone in the center of the crystal. According to one theory of faden origin, uneven crystal growth creates microcracks or channels that allow hydrothermal fluids to enter the crystal, where they become trapped as millions of tiny, fluid inclusions.

Gwindel quartz, named for a Swiss locality, forms when thermal changes create positive and negative electrical charges on different parts of the same crystal. These opposing forces cause the main crystallographic axis to torque or rotate, thus forming an unusual helicoidal or spiral, crystal. Gwindel quartz crystals are recognized by their distinctive offset or "stacked," parallel crystal growth.

Floaters are yet another interesting form in quartz crystals. These are "free-form" crystals that grow within hydrothermal fluids from tiny crystalline seeds that are not attached to a base or matrix. Floaters are usually quite distorted, with little apparent symmetry and a seemingly random arrangement of faces.

As forms of quartz that are a record of conditions that occurred during crystal development, scepters, faden, Gwindel, and floaters are some of the reasons behind our endless fascination with quartz crystals.

ROCK & GEM

Make A Sand Painting

Brazilianite

Brazilianite, $NaAl_3(PO_4)_2(OH)_4$, a sodium aluminum phosphate hydroxide, is an unusual mineral that was identified by American mineralogists Frederick Pough and Edward Henderson in 1945 while they were searching for mineral deposits in Brazil.

Brazilianite and apatite are the only phosphate minerals to be commonly used as gemstones. Brazilianite has good luster and a yellow to greenish-yellow color. At Mohs 5.5, it is not as hard as most gemstones, but it is one of the hardest phosphate minerals.

Brazilianite is found in the unusual and rare phosphate rich pegmatites of Conselheiro Pena, in the state of Minas Gerais, Brazil. More recently, brazilianite was discovered in specimens collected at the Palermo Mine in New Hampshire. This discovery was surprising since many geologists had carefully studied this famous mine for many years and still had missed this new mineral.

Brazilianite forms short prismatic and wedge-shaped crystals. Though brazilianite is a rare mineral, it is almost always found as crystals or crystal clusters, and massive examples are almost unknown. Cleavage is perfect in one direction and its fracture is conchoidal.

The discovery of brazilianite proves that interesting and beautiful new minerals can still be found, even in localities that have been studied for many years. Keep your eyes and mind open, and maybe a mineral can be named after you someday!

KIDS

by Steve Brick

Careers in Geology

Rock & Gem Kids Quiz

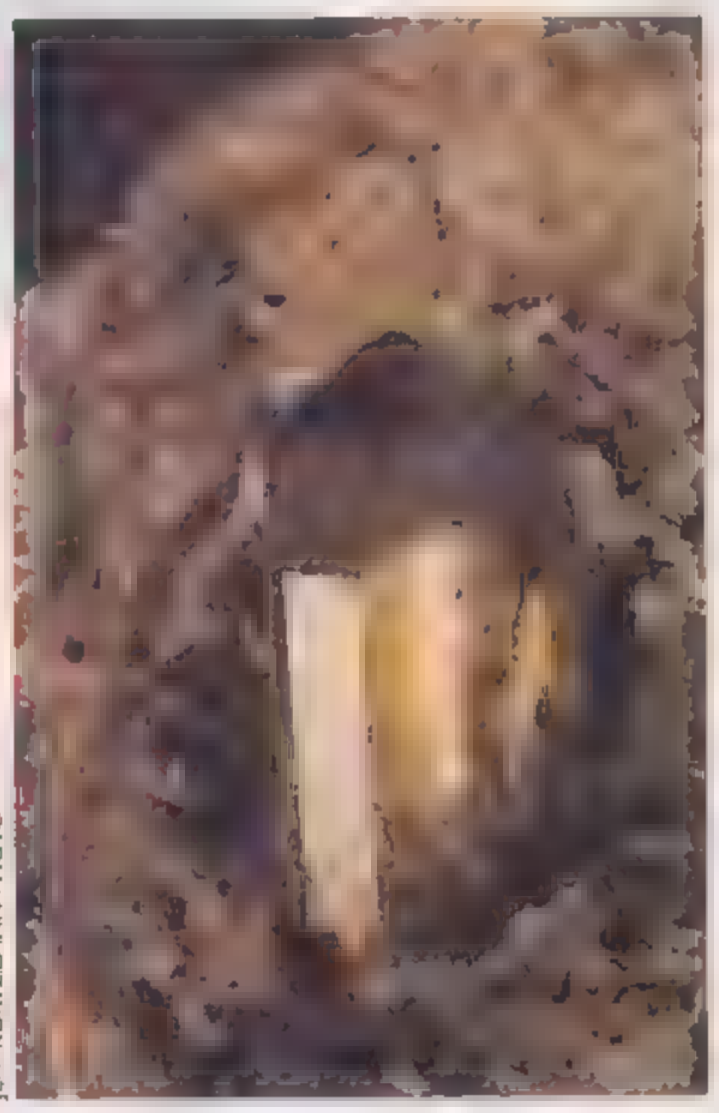
Mexico's Camino Real Mines

PART II:
This Road Leads to Silver Riches

Story and Photos by Bob Jones

In Part I of this article, I described several of the mining areas along Mexico's El Camino Real. It is no accident that a number of early Spanish silver mines, some of which have evolved into fine recent specimen sources, occur within hailing distance of this important early road.

The invading Spaniards enlarged the road to reach the mines, sources of Spain's newfound wealth. Some of these mines have been producing silver for 400 years or more. And as metal recovery techniques improved, they have been important sources of other metals, as well.



JEFF KURTZEMAN PHOTO

The iron mine at Cerro de Mercado is best known for its gemmy yellow fluorapatite crystals.

The Veta Grande vein in Guanajuato produced some of Mexico's most spectacular silver specimens.

Crecdite is a fairly rare mineral, but it was found in abundance at the El Potosi Mine in Santa Eulalia

Some of the most colorful mimetite ever to come from Mexico is from San Pedro Corallitas, Chihuahua, west of El Camino Real.

EVAN JONES COLLECTION

The silver mine at Zacatecas also produced some fine pink calcites, rich in cobalt

Those mines that early on hit borassca (low-grade or unproductive ore, usually recalcitrant sulfides), were abandoned by the Spaniards, but as mining and milling techniques improved, they were worked again and again. Once closed, they often became fruitful hunting grounds for specimen collectors, as the abandoned workings gave access to small ore pockets and secondary species that were either ignored during gold and silver mining or formed after mining due to weathering.

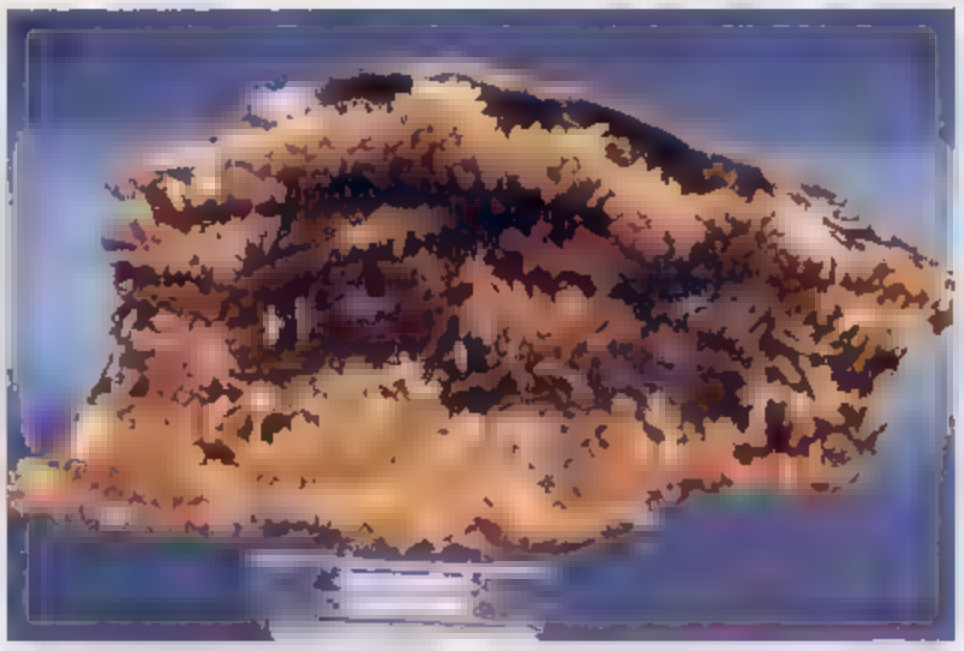
Moving north from Mexico City along El Camino Real, I described minerals from mines in the states of San Luis Potosi and Zacatecas. Two other famous mining areas are in the states of Guanajuato and Queretaro.

For the lapidary and gem artist, Queretaro has been a wonderful source of precious opal. Many of the opals found in rhyolite here exhibit internal fire, but the hallmark of these opals is the colorful groundmass of yellow-orange to rich red, attractive even when there is no significant internal play of colors.

While most Mexican precious metal mines were found by the Spaniards in the 1500s, the opal mines in the Queretaro region were not opened up until the mid-1850s. Once the value of the opal was realized, a number of small, independent mines were opened. Digging opal here is never easy because of the rock-hard rhyolite matrix, but the small, rounded masses of precious and fire opal unearthed are worth the effort. The better opal is a rich color that holds flashes of fiery color, usually red. The best opal is transparent, or nearly so, and can be used in jewelry. The clouded opal, still a vibrant overal, color, is often carved or shaped and polished.

Of course, every lapidary knows of the magnificent agates and geodes found in Mexico, particularly northern Chihuahua. Several ranches, centered around Ojo Laguna, have produced some of the world's finest gem agates ever found. That area will be described in Part III of this series.

The state of Guanajuato hosts an amazing silver deposit highlighted by the Veta Grande Mine, a huge vein of rich ore still being worked even though the original discovery was made in 1548! Guanajuato has been so productive that it has long been considered Mexico's richest silver camp!



EVAN JONES COLLECTION

The mines around Santa Eulalia have produced wonderful dogtooth mimetite crystals on limonite.

The silver of this region was discovered by traveling mule skinners. Camping just off El Camino Real, they lit their campfire, only to discover a shiny metal oozing from the rocks in their fire ring. They found the silver vein called the San Barbabe, and almost immediately, a rush was on.

By 1558, the huge San Juan de Rayas Mine was developing. Its surface buildings look like, and even served as, a fortress. Mining here has gone to great depths to follow the rich ores, the Veta Madre (mother lode) was 150 feet wide in places! This vein was mined along an eight-mile length and produced untold riches. As the region produced more and more silver, a mint was built to handle coinage.

Minerals from the San Juan de Rayas were typical of the silver deposits in Mexico, fine pyrargyrites, superb small proustites, acanthite, and more. The gangue minerals are equally interesting to collectors: wonderful calcite crystals, some showing rare forms, and fine snow-white and amethystine quartz.

Guanajuato was the most important silver producer in Mexico, and its large, deep veins forced the development and use of a variety of mining and milling equipment, including huge horse whims, or malacates. The Patio Process was also used throughout this area until later decades.

The state of Durango really has only one major mineral source to boast about. Cerro de Mercado, named after Gines Vasquez de Mercado, who discovered the deposit in 1552. Vasquez de Mercado, like all gambusinos (prospectors), was really searching for gold and silver, and the odd shape of the hill that later bore his name attracted his attention. Upon investigation, Mercado realized the hill was a massive deposit of iron minerals. This 700-foot-high hill was so rich in iron that it was first called Iron Mountain.

continued on next page

Mexico's Camino *from page 61*

Mercado's find proved to be a replacement deposit of nearly solid iron oxide, originally called martite. The name has been discredited, for the mineral is really just a form of hematite, the major iron oxide. Keep in mind that iron oxides are easy to smelt. Hematite is exceptionally rich in iron, usually running about 70 percent iron and 30 percent oxygen. The ore here assayed out at about 60 percent iron, still a very respectable percentage.

The term martite has often been applied to crystals of altered magnetite. Chemical and crystallographic tests have shown such crystals to be octahedral hematite pseudomorphed after the primary magnetite.

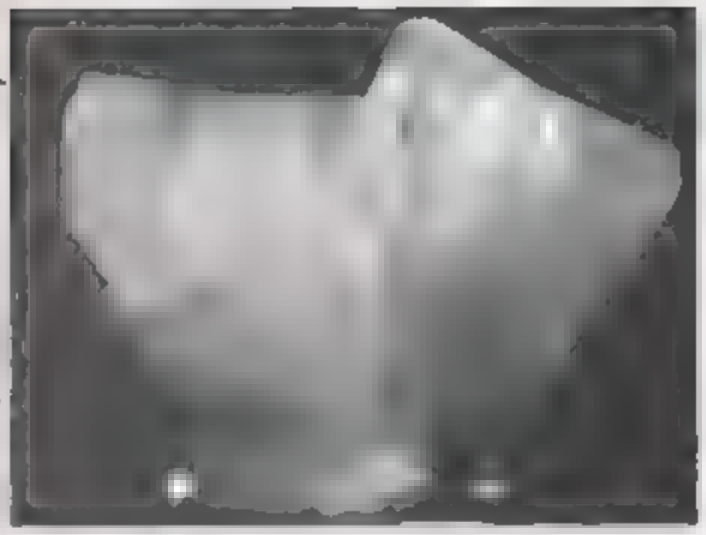
For collectors, the deposit has produced a large number of hematite pseudomorphs. They are not particularly attractive—dull, lusterless brown with slightly rounded crystal edges—so iron oxide specimens have not created a great stir in the collector community. But this deposit also produces single gemmy, yellow, hexagonal crystals of fluorapatite by the tens of millions. Because the crystals are yellow, they are often referred to in Mexico as amarillas, or "yellows."

Single crystals are common, as they easily part from the brown-white clayey matrix in which they occur. They are so abundant that when you drive along the dirt road leading to the mine entrance, the roadside gravel is littered with them. They range in size from the thickness of a pencil and maybe an inch long to well over an inch across and 3 or 4 inches long. Each of the vertical prism faces tends to be slightly curved, so they appear rounded when looking down the long axis. The terminations are pyramidal rather than flat, as is seen in some apatites. The overall effect of the crystals is quite symmetrical and pleasing.

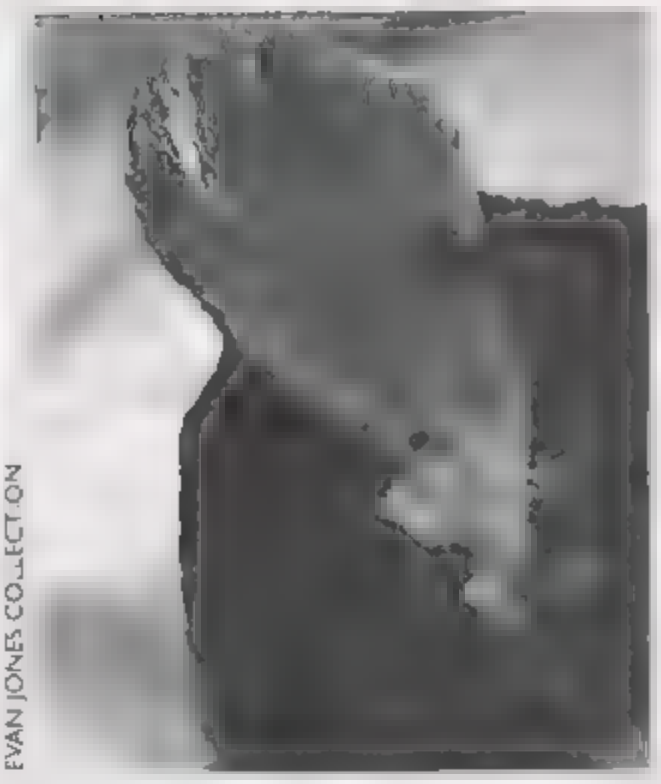
Virtually all the crystals from Cerro de Mercado are gemmy, though some are crazed and cloudy at the base. The repeated blasting of the iron deposit shattered untold numbers of these lovely apatite prisms. Because most are clear and colorful, they can be faceted even though they are only Mohs 5. The yellow color persists best in the larger faceted gems.

On a drive into the mine, we were able to gather several hundred small crystals off the roadside. In the mine, collecting was not allowed, as blasting and mining was ongoing. That did not matter as local dealers had many crates of loose crystals of every size.

Matrix specimens were another story. The apatites form in clay seams and often have iron staining, which is difficult to remove. A greater problem is that the rock is friable and easily crumbles, so when a

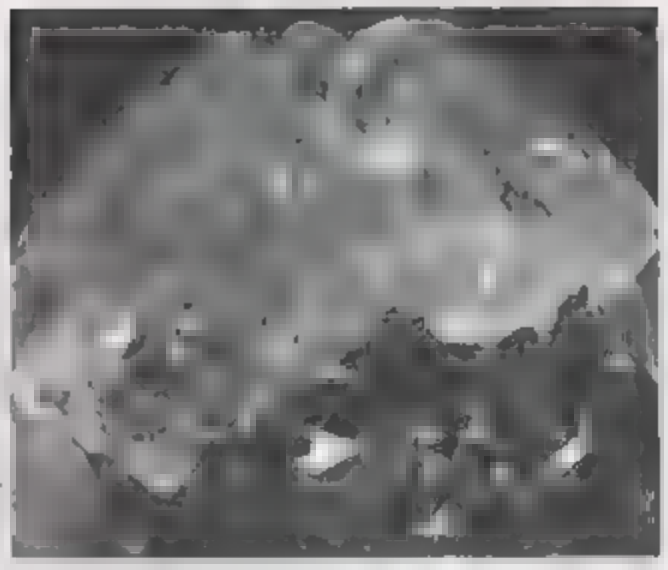


Not only did Guanajuato produce tons of silver, it also provided collectors with choice calcites like this sharp twin.



EVAN JONES COLLECTION

Mapimi has produced the world's finest legrandite specimens.



EVAN JONES COLLECTION

The silver mine at Naica also produces choice galena with delicately colored fluorite crystals

matrix specimen is obtained, it has to be stabilized. I see nothing wrong with that, as long as a prospective buyer knows the process has been used.

Another interesting mine in Durango is at the little village of Rodeo. The El Ampero Mine only produces one species, superb calcite! It was unknown to the Spaniards, but it played an important role in World War II. The mine produces two different types of calcite, one of which is very important in optical work. The other type is fine-bladed display groups we often call "angel wing" calcite. These large blades with carved faces can be 6 or 8 inches across and come in diverging clusters, the size of which is determined by the effort of the collector to peel these massive specimens off the walls of the deposit.

Calcite-rich solutions surged up through a chimneylike opening in the volcanic host rock. The initial solution deposited water-clear optical calcite an inch or two thick on the walls. Atop this special calcite small, curving, tan blades of white calcite, sometimes lightly tinted with iron oxide developed. Finally, solutions filled the cavelike opening, and huge blades of opaque white calcite developed.

When this mine was operating, the more valuable calcite was the optically clear material. Miners would peel away the large specimens and simply drop them on the floor so they could mine the optical-grade calcite.

Calcite's perfect cleavage in three directions led French mineralogist Rene Hauy to develop the science of crystallography. He brought together the work of others to devise this new science.

When I visited the National Mineral Museum in Paris, I was delighted to see Hauy's original notes about this discovery. Right next to his hand-written notes were the actual pieces of cleaved calcite he studied. That same museum has the original Mexican bournonite that Count de Bournon studied and reported as a new mineral. The specimen came from one of the mines along the Camino Real!

On one calcite collecting trip, it was dark when we exited the El Empero Mine

We decided not to venture too far, so we drove down off the mountain and to within a stone's throw of the paved highway, and camped in a large level area. The next morning, I was walking around the area before breakfast and realized the ground was littered with nice, large, stream-tumbled boulders of red and yellow jasper, nice cutting material! As far as I know, the staff is still there!

Any discussion of the mines of Durango has to end up at Mapimi, Mexico's most prolific mineral species source. It has yielded dozens of fine species and over a million collector minerals. Mina Ojuela, which consists of many mine shafts and nearly 300 miles of underground workings, is the only important mine in the district. It also can boast a small place in mining history.

The ore bodies of Mina Ojuela were very difficult to reach from the valley floor. Steps had to be cut into the sheer limestone cliff to gain access to the diggings. At the end of the 1800s, John Roebling built a suspension bridge there using braided steel cable. He was the son of Washington Roebling, who developed this innovation.

Located on La Buta de Mapimi Mountain in the Sierra de Mapimi, this huge deposit seems like a typical lead-silver ore body, also high in copper and zinc. Once ore mining commenced and later specimen mining got underway, Mapimi proved anything but typical.

Mapimi was located late by Spanish standards, in 1598. The Spaniards pursued mainly near-surface silver ores, and by the late 1800s, deep mining was well underway. It continued on and off for centuries until after World War II, when it became too costly to continue. During mining, quantities of fine specimens were found and saved. But after the mine closed, miners recognized the property's value as a specimen mine. They formed a cooperative and continued mining for specimens. Certainly this cooperative accounts for the immense increase in specimen production that continued into the latter part of the 1900s. Since that time, outside groups have attempted specimen mining ventures with only marginal success.

Of the more than 175 species found at Mapimi, the one you'll most likely recognize is adamite, a zinc arsenate that can be nearly colorless, yellow, yellow-green, green, blue, and on rare occasion, red-violet. Tens of thousands of specimens were brought to light. Sometimes, miners would open a vug filled with *tons* of adamite specimens. Prior to the work of the cooperative, adamite was a relatively scarce, some say rare, mineral.

Adamite is occasionally seen as single dipyramidal orthorhombic crystals, but collectors are far more familiar with the rosettes, spheres, and radiating fans of multiple crystals, which are its common habits. Under ultraviolet light, most adamite glows a beautiful lime green due to a trace of uranium salts. Some specimens contain traces of copper or iron that inhibit the response.

Mapimi's sulfide minerals—galena, arsenopyrite, pyrite, chalcopyrite, and sphalerite—make it seem a pretty typical replacement deposit. None of these sulfides produced an abundance of fine crystal specimens. More importantly, as these sulfides were attacked by weathering, they provided the ingredients for a host of superb secondary carbonate, arsenate and oxide minerals. Of these many sulfides, the arsenopyrite played a major role for it provided the arsenate to form adamite, paradamite, legrandite, arsenosiderite, kottigite (sometimes spelled koettigite), carminite, austinite, duftite, dussertite, mimetite, and scorodite. No other silver mine in Mexico produced such a variety of fine arsenates in quantity.

Among this group of arsenates, legrandite stands out as an uncommon and highly valued Mapimi collector mineral. Minerals like austinite and mimetite were more common, but less showy.

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Mexico's Camino Real Mines *from page 63*

I imagine everyone has seen the world's finest legrandite, the Aztec Sun, on display or in photographs. It is now at the University of Arizona and is frequently displayed at the Tucson Gem & Mineral Show. I can take credit for naming that specimen in a *Rock & Gem* article about its discovery, the first such public announcement after the specimen was obtained from a miner. A second legrandite, The Indian Club found at the same time, is a so well known and is in the American Museum of Natural History collection.

Legrandites are bright yellow unless adversely affected by being submerged too long in acidic waters. The soaking tends to dull them to a drab tan. Crystals are almost always prismatic and usually form in diverging bundles radiating from a common starting point. They are generally an inch or so long, anything longer is considered uncommon. The Aztec Sun consists of two diverging sprays of crystals, each nearly 5 inches long. The Indian Club, a remarkable long, tapered spray, measures about 7 inches long!

Mapimi legrandites occurred in the hard, siliceous, brown iron matrix, probably about 1,000 feet down. Early evidence of legrandite may have been encountered in the early part of the 1900s, but it was not until the late 1960s that a significant find was made. The specimens that came out then varied from bright yellow to dull tan. As the water table rose, crystal pockets would be submerged. Miners accessed the source during dry spells.

The mimetite from Mapimi is very attractive, forming as botryoidal velvety crusts of bright to dark green. It forms a delightful matrix upon which some of Mapimi's fine yellow wulfenite crystals are often found. The contrast of the green mimetite with the rich yellow wulfenite, whose crystals seldom reach an inch on an edge, is excellent. The two lead minerals make a very attractive combination.

Heading north from this famous locality, we pass a small, yet important, specimen source in the southern part of the state of Chihuahua. Near Camargo there is a small moonstone mine that has been producing nice gems recently. They typically flash the well-known white to soft blue response due to the internal microtwinning of the feldspar crystals. As light enters the crystal it is scattered by the paper thin, nearly invisible, twinning planes of the orthoclase feldspar. On a trip to the mine, I traced the seam of feldspar in the volcanic rock for over 100 yards across the face of a hill from which you could see Naica, a more noteworthy mine.

Naica is a rather amazing locality for several reasons. It is a very rich silver producer and an excellent source of superb fluorite, garnet, brilliant and often twinned galena, and, of greater interest, superb selenite gypsum. Its fluorite is particularly interesting, colorless to pale green cubes, more frequently octahedral crystals, usually associated with fine galena.

Naica, discovered in 1794, became well known in the mineral world when the Cave of Swords was broken into in the 1920s. A vug that extended at least 65 feet into the rock and high enough to easily walk into was lined and criss-crossed with selenite crystals ranging from a fraction of an inch to 5 inches thick and from a few inches to several feet long! Some sprays span 4 or 5 feet across.

A few years ago, multiple small vugs of selenite were revealed about 1,000 feet farther down in the Naica Mine. One vug opened into a large cave filled with huge selenites, some of them a dozen or more feet long. Others were single monoclinic crystals 6 feet or more across!

But, this was only a preview to a cave that proved to hold the world's largest free-standing selenites! Some reach 50 feet in length. Two people have trouble touching hands as they reach around these monsters. Unfortunately, this cave has two significant deterrents to being opened to the general public: the temperature in the cave is close to 150 degrees F. and the humidity is close to 100 percent.

The latest report on this amazing natural phenomenon is that the company has put a Plexiglas shield in the entrance so visitors can look into the cave. Persons 65 years of age and older are not allowed to go in.

In the early days, the local personnel at Naica made a concerted effort to save collector specimens and sell them to visiting dealers. The money was used for the miners' medical supplies and other needs. Today, miners do their best to bring to light good specimens, which they sell on their own in spite of management's restrictions on specimen mining. For this reason, specimen production is somewhat sporadic.

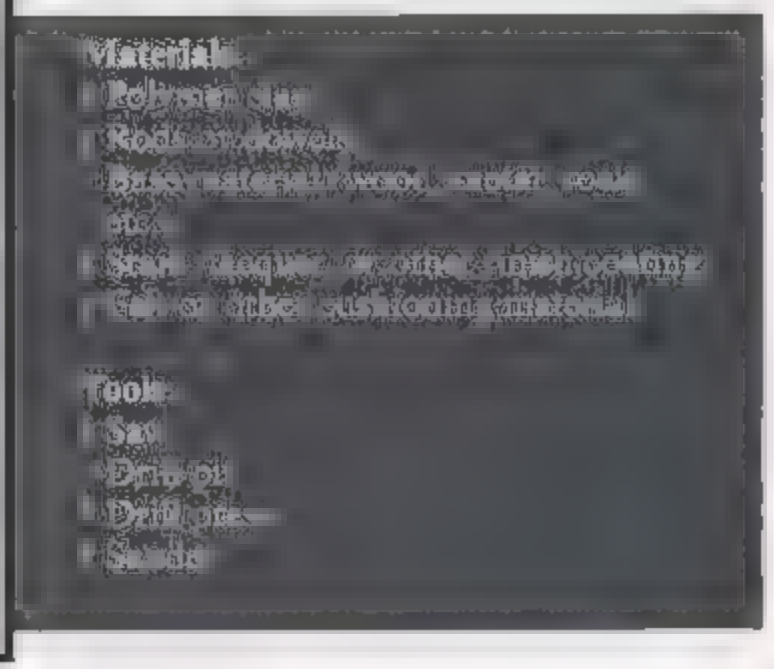
The state of Chihuahua is also host to the several mines clustered around the towns of Santa Eulalia and Aquila Serdan. This area has been an important source of many collector species. In the northern part of the state are the world famous gem agate beds that have been mined for well over 60 years! Both these prolific specimen sources will be described in Part III.

PROJECT

Make Safe Mounts for Your Collectibles

Display Your Specimens to Their Best Potential

Story and Photos
by David Abbott



Surely, every collector has struggled with the question of how to display his collection. Those little white cardboard boxes may be great for transportation to and from the show, but they're not terribly attractive. Some dealers also fix their specimens in the box with putty or clay, which can be a challenge to remove.

Discarding the box, and setting your fossils and minerals on a shelf by themselves sometimes works, but typically doesn't display the specimens' best features. Furthermore, I have found commercial Lucite stands to be only marginally useful, due to the unpredictable shapes of specimens. So my dilemma was to find some way to display my specimens to their best potential, without doing anything "permanent" or potentially damaging to them.

For relatively lightweight specimens, I found the answer in polymer clay. There are now a variety of manufacturers; I have experimented with Fimo and Sculpey brands. The Fimo clay is firmer and holds its shape better while cooking. A disadvantage is that I broke a specimen while trying to shape this very firm polymer around it. The Sculpey brand was far easier to shape and mold to the specimen. A disadvantage was that I had to re-make a couple pieces when they failed to hold their shape in the oven. Both brands are available in a variety of colors; I recommend something neutral. This stuff goes pretty far with cabinet specimens, so large quantities are usually not necessary.

For the stands, one needs essentially three materials: polymer clay, material for a base, and rods for suspending the specimen off the base. I obtained base material by sifting through the "shorts" bin at a hardwood store. I was able to obtain small pieces of mahogany, maple, oak, and American walnut at prices below $1 per board foot.

For rods, I visited a welding-supply store. Brazing rods (a bronze alloy) are sold by the pound, and are much cheaper than a single rod from a craft store. I used ⅛-inch rod, as this is a very common drill-bit size and has a substantial look. Wooden dowels could also be used, but the look doesn't appeal to me.

Start by selecting the bottom of the specimen. For some specimens, this is a challenge. For others, there is an obvious not-so-good-side. Tear off a strip of regular kitchen aluminum foil. Using a blunt-pointed tool or your fingers, so as not to tear the aluminum, gently shape the foil to the bottom of the specimen. The foil serves two purposes: it prevents the clay from sticking to the specimen and it serves as a platform for cooking the clay.

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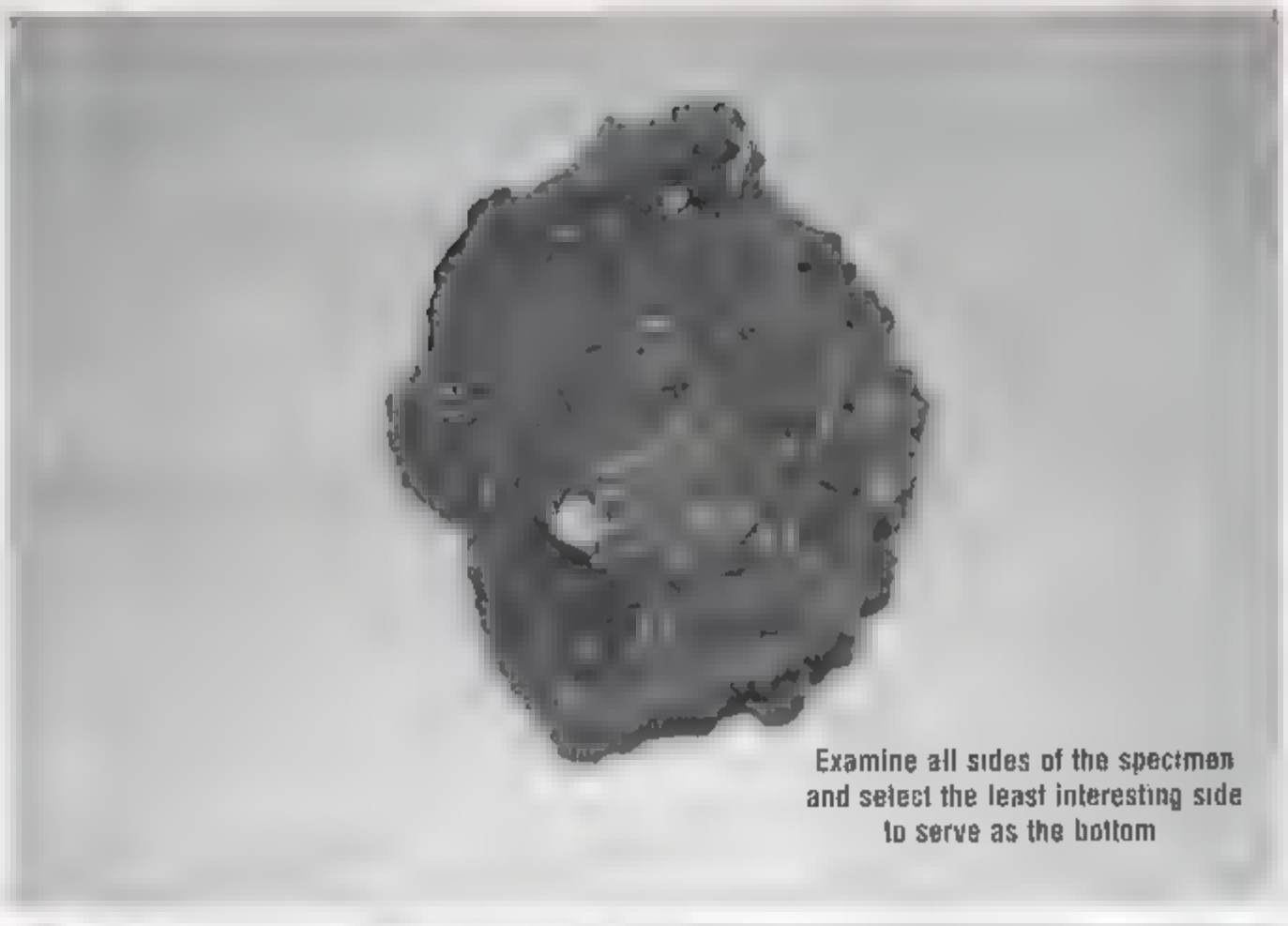
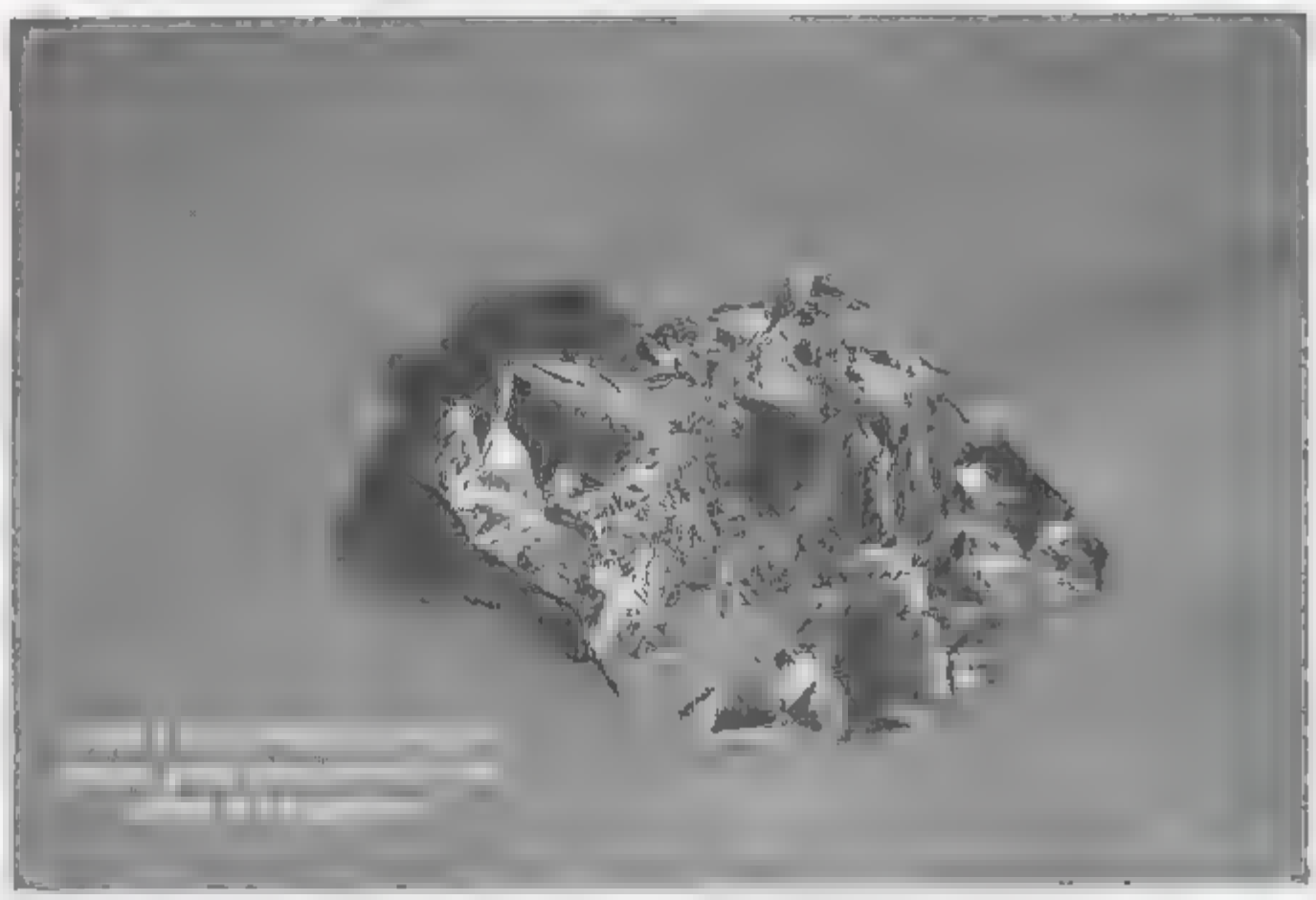
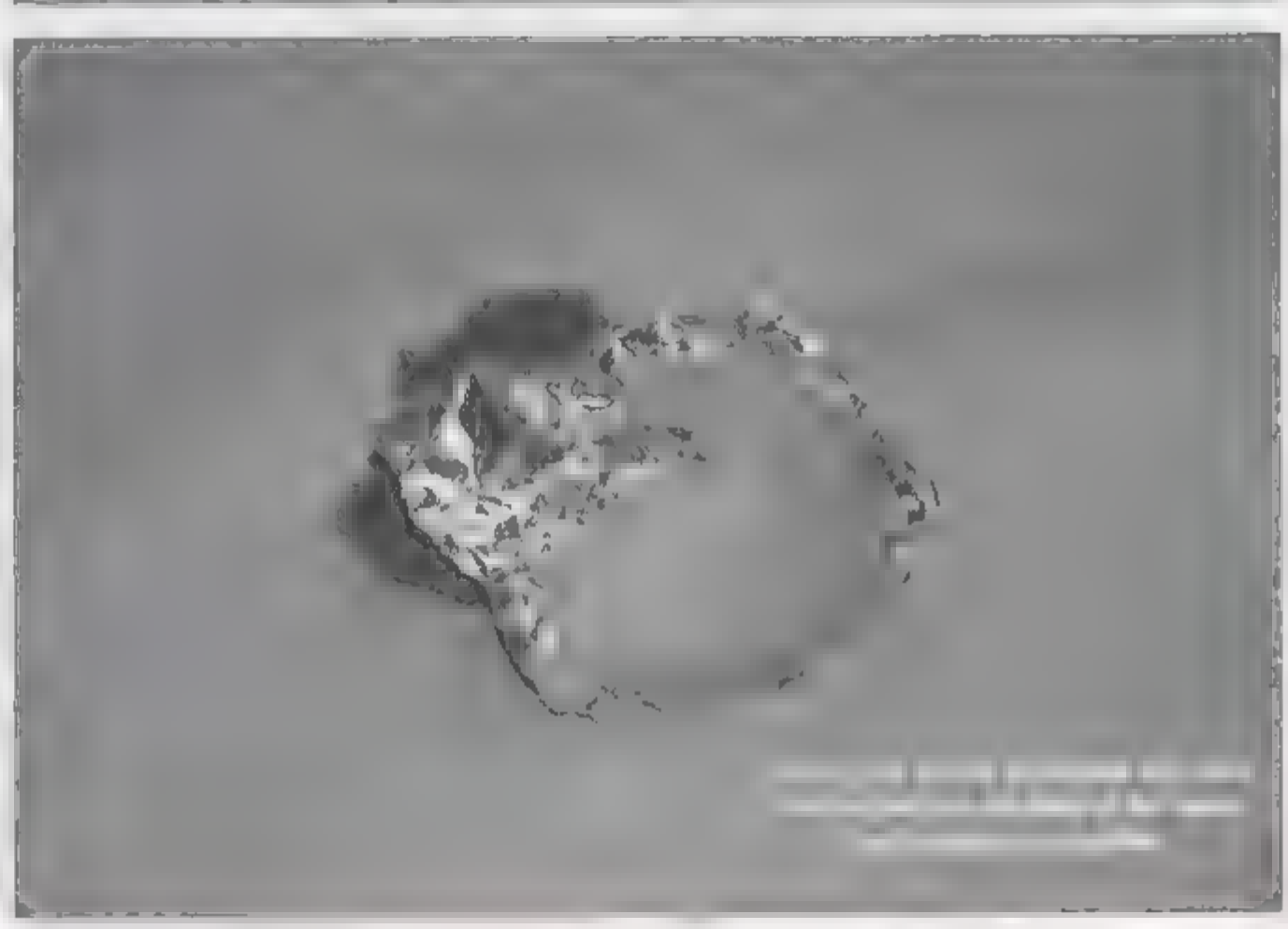


Examine all sides of the specimen and select the least interesting side to serve as the bottom.





PROJECT

Make Safe Mounts *from page 69*

When the polymer clay has been cured, it will be form fitted to the specimen.

Press your choice of polymer clay onto the foil and into as many of the nooks and crannies as possible. The hardened clay will cradle the specimen without adhering, so cover enough of the bottom of the specimen to hold it firmly. Gently remove both clay and foil as a unit and place them in the oven according to the directions provided by the clay manufacturer. A note on the cooking: The clay remains quite flexible while it is hot, so be very careful when removing it from the oven to avoid distortion. After cooling, the clay hardens to a machinable texture. The cooking time is more art than science, and overcooking will change the color of the clay.

The next step is to prepare your base. If you use random ends as I did, you will need a saw and sanders to obtain the size and shape desired. I also experimented with scrap metal as a base. A slug of solid copper, which is quite heavy for its volume, provides a very stable base that is unlikely to tip over.

After shaping the base to your satisfaction, place the specimen in the clay form and place it against the base as a guide to determine the best place to drill your holes. You will want the specimen centered as much as possible. Two or more holes are recommended, as they provide much more stability. Drill the holes with a size of bit consistent with the rods to be used. The base may now be finish sanded and stained or finished to your preference. Apply felt or another cushion to the bottom of the base.

Spend some time evaluating your specimen to determine a display height that will present it attractively, don't forget to consider the thickness of the base. Cut the rod to length and insert the rod pieces into the holes in the base.

Mate the specimen with the clay form. Place the clay form against the ends of the upright rods and mark where the next holes are to be drilled. It is important to consider weight distribution, symmetry, etc. to assure that the finished piece will balance and be attractive.

Mark the clay for the holes and drill as you did the base. In all drilling operations, be careful not to drill completely through your material. Place the clay form on top of the rods to check the height. If necessary, one or all rods may be shortened to correct the display attitude. Once you are satisfied, it is generally a good idea to place a drop of isocyanurate (super glue) in each hole.

Now, set your specimen on its new base and admire. Obviously, this process is for one-of-a-kind stands. However, the cost is minimal, the effort rewarding, and the results unique. I have found this technique to be addictive, and highly suitable to fossils, as well as minerals.

The placement of the rods in the base and the corresponding holes in the polymer clay should balance the weight of the specimen.

An Acrocanthosaurus Finds a New Home

The nearly complete skeleton of a rare Acrocanthosaurus atokensis dinosaur (lower left) was unearthed from Oklahoma's Mountain Fork River by rockhounds Sid Love and Cephis Hall.

Rockhounds Excavate a Dinosaur in Southeast Oklahoma

Story by Doris Perkins / Photos Courtesy Museum of the Red River

When Cephis Hall and Sid Love found the first bone in the Mountain Fork River in 1980, they had no idea that they had discovered a rare, nearly complete skeleton of an Acrocanthosaurus atokensis (high-spined) dinosaur. Members of the local McCurtain Gem & Mineral Club, Hall and Love were to embark on a project that would take four years to complete.

Taking advantage of the milder climate in the southern part of the state, they worked on winter weekends and holidays and into the hot summers, quietly excavating bones from the bottom of a former gravel pit. Neither man had any formal training in geology or paleontology, but were strictly amateurs who were determined to preserve the bones they were finding.

They were careful to photograph and label each bone as they dug them from the layer of Lower Cretaceous soil. Fragments of sempetrified wood were also found in the layer of blue-black clay. McCurtain County, Oklahoma, is located at the western end of the Ouachita (pronounced *wash*-a-taw) Mountains, a mass of completely folded sandstone, shales and flints that geologists think were formed in the Paleozoic Era. Many Indian artifacts have been found along the rivers and streams, they indicate that the area was occupied as far back as 8,000 years ago. A Clovis point projectile discovered in the county is now on exhibit at the Smithsonian in Washington, D.C.

The elevation in the area where the dinosaur was found is only 450 feet. The rocks in the southern part of the county are mostly sedimentary rocks of the Gulf Coastal Plain from the

It took club members, assisted by Allen Graffham and Neil Larsen, only two hours to assemble the skeleton cast in its new home in the Museum of the Red River.

Cretaceous period. The limestones contain an abundance of fossil remains. Echinoids, gastropods, graphae, and pelecypods are fairly common fossil casts. Seldom is a fossil found with its original covering, since the soil is acid and there is a heavy annual rainfall.

No petrified wood of any quality has been found except near the dinosaur pit, where there were numerous logs of Cordaites wood in the bed of the river. The northern part of the county is timbered hills and valleys. A variety of quartz crystals is found in this western edge of the Ouachita Mountains.

In some respects, the Ouachitas can be thought of as a continuation of the Appalachian Mountains. The Ouachitas appear to be a rather small mountain range, but are part of a long range that extends from eastern Mississippi to west Texas. This is called the Ouachita tectonic belt. It is a fold-and-thrust belt formed by compressions. These are the same mountains that furnish the Mount Ida, Jessieville, and Hot Springs, Arkansas, quartz fields. Clear quartz crystals, tabulars (some with green chlorite inclusions), skeletal, scepters, and a few crystals with black inclusions have been found on club field trips in McCurtain County. The northern part of the county has the same quality quartz crystals as those found in Arkansas, including many singles and clusters with fine points.

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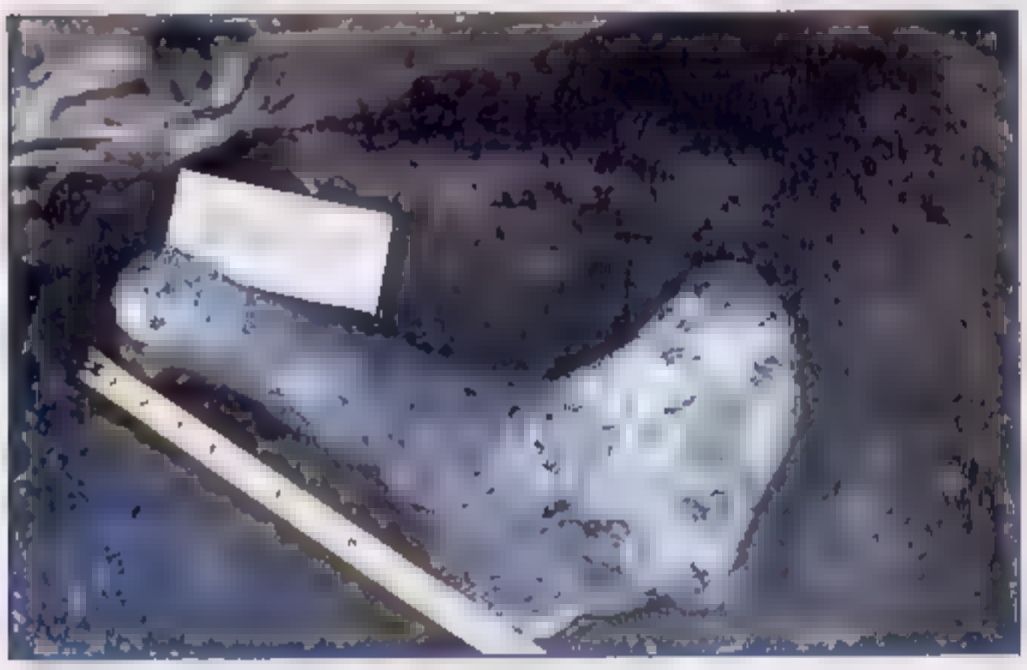


Hall and Love removed the skeleton from the blue-black riverbed clay using only hand tools

A homemade sled helped the rockhounds move the 600-pound skull across the ravine for removal.

An Acrocanthosaurus Finds a New Home *from page 71*

Allen and Fran Graftham purchased the Acro bones and sent them to the Black Hills Institute for stabilization

Hall and Love had no previous experience in preserving such a large fossil, but contacted knowledgeable others who told them how to preserve their specimens. The bones were at the bottom of a rock pit, covered with pyrite disease. As the pair excavated the bones, they photographed carefully wrapped, and stored them. Excitement mounted when Hall unearthed the teeth of the dinosaur. Then the complete skull was found. It was encased in plaster and the 600-pound load was transported on a hastily constructed ramp across a deep ditch to a tow truck for removal. Hall and Love were able to work quietly and keep the location unpublicized. They were not able to work during the wettest winter months, but took advantage of the warmer spring and summer seasons. All the work was done with hand tools.

The first Acrocanthosaurus bones were found in 1940 in a section of Oklahoma about 150 miles north of Idabel. Acros are also known to have been found around Glen Rose and Fort Worth, Texas, and in northern Texas, as well as near Nashville, Arkansas. However, this one is the most complete skeleton to be excavated to date.

The landowners had given the men permission to dig, but eventually filed suit in federal court to take the skeleton. The court ruled in favor of Hall and Love, who had pictures of agents for the landowners helping move the bones.

The late Dr. Walt Dalquest of Wichita Falls, Texas, identified the dinosaur. The bones were sent to a neighboring state's university for cleanup and preparation. However, it seemed that they were not being processed, so Hall and Love collected their bones and brought them home.

They offered the bones to another university, which turned them down. Eventually, Allen Graftham, owner of Geological Enterprises in Ardmore, bought the bones and sent them to the Black Hills Institute of Geological Research in Hill City, South Dakota. There the bones were conserved and four casts were made. Meanwhile, Love had died, and Hall was left with the task of finding a home for his cast. The actual bones had been sold to a museum in North Carolina. The real fossil cost $2 million to restore and was reportedly sold for $3 million.

McCurtain County, with a population of approx. 35,000, is the fourth largest geographical county in the state, but has many low-income residents. There was no way the county could afford to buy the original bones, and there was no space large enough to display a 40-plus foot cast which would stand over 12 feet high.

The Idabel community is fortunate to have the Museum of the Red River dedicated to anthropological artifacts and art from the Americas. This museum was began by Quintus and Mary Herron in 1974. They had become interested in archeology and begun collecting artifacts, and needed a space for them. The museum was planned and built, and given to the city of Idabel. It is directed by a board of trustees. The local gem and mineral club meets there monthly and held its annual show in the museum for several years until they outgrew the space. The board of the museum was approached about housing the local dinosaur called the Acro. The board turned it down since, it was not interested in dinosaurs.

Some of the bones of the cast were shown at local club meetings and shows until there was quite a bit of interest in them. The cast of the skull was nearly lost one year when it was shipped to Oklahoma City to be displayed at a gem and mineral show. Hall became a local celebrity and was often invited to schools to talk to the science classes. The local people felt like the cast was "our" dinosaur.

After several years had passed, the Museum of the Red River board was approached again, and this time it promised to build a wing to house the cast if the community would raise the money to buy the cast and pay for its articulation. Two other club members, retired teachers Sallie Webb and Paulette LeGasse, accepted the challenge and set about rais-

Paleontologist Dr. Louis Jacobs shows Henry Moy, Paulette LeGass, and Dr. Adrian Hunt where fossils are prepared in the lab at Southern Methodist University.

ing money to buy the cast and pay for the preparation They along with other club members, went into schools and challenged the students to help Students in one school collected $2,000 in change Local businesses, clubs, and service organizations were asked to support the project. Webb and LeGasse were so successful that they raised 150 percent of their goal

The 18,000-square-foot museum expanded with an additional 2,000-square-foot wing designed to house the cast The museum board members and interested club members were led by museum director Henry Moy to visit other museums and research their dinosaur displays Special assistance came from Dr Louis Jacobs, a paleontologist from Southern Methodist University in Dallas, Jim Diffily, from the Fort Worth Museum of Science and History, Norman Ikeda, formerly with the Academy of Science in Philadelphia, the Smithsonian Institute's National Museum of Natural History, and the Los Angeles City Museum of Natural History, and Dr Adrian Hunt, director of the New Mexico Museum of Natural History in Alberquerque, New Mexico, as plans were being made to display the cast

Club members also contributed to the project, some of them transported the cast pieces to South Dakota to be prepared for mounting Finally, the cast was ready to be shipped back to Idabel in the spring of 2005 Club members were excited to be able to help assemble the cast when the Black Hills Institute's Peter Larson came to mount the display The entire cast was in place within two hours of the unerating Cretaceous fossils and specimens of quartz, all collected in McCurtain County, were displayed to complete the new addition School students who raised the most money were invited to attend a pre-opening viewing of the giant cast

Moy planned a festive opening that included a presentation by Dr Jacobs and other events to give the donors a view of the new wing and its contents.

The museum, the largest one in a 150-mile radius, is now a favorite site for school field trips. There is a student activity director who provides educational opportunities for those students who visit the museum on a scheduled field trip The addition of the Acro just enhances the opportunities for school students and the public to see and enjoy all that the museum offers. The dinosaur cast seems to be an immediate attraction that has swelled museum attendance. Attendance during the weekend of the opening was half as much as during the whole of the previous year The museum celebrated its 30th anniversary in April, 2005

The Museum of the Red River is located in Idabel, Oklahoma, on the U.S. Highway 70 South Bypass, 70 miles northwest of Texarkana, Texas. U.S. Highway 70 is the east-west route through Idabel U.S. Highway 259 is the north-south route through Idabel from Longview, Texas to Ft Smith, Arkansas. The museum is closed Mondays, but is open 10 a.m. to 5 p.m Tuesday through Saturday. Sunday hours are 11 a.m. to 5 p.m.

For more technical information about the geology of the area, see *The Geology of the Broken Bow Uplift* an introduction and field trip guide by Neil Suneson at the Oklahoma Geological Survey, 100 East Boyd St., Norman, OK 73019-0628

Tourmaline AND Spodumene

You'll Find Them Both in Pegmatites

. Story and Photos by Kenneth H. Rohn

Although spodumene and tourmaline are only kissing cousins, they do have one thing in common: They are both the products of pegmatites. Spodumene belongs to the inosilicates, and tourmaline is in the cyclosilicate group. The inosilicates are called "chain silicates" because the tetrahedrons (four-sided pyramids) are joined together in a single or double chain. The cyclosilicates are composed of a ring structure. Two ions of oxygen for each silica tetrahedron are distributed among other tetrahedrons in the mineral. This makes a very strong, often elongated crystal, typically found in the tourmaline species.

KRISTALLE

Spodumene, variety hiddenite, is only found in Alexander County, North Carolina.

GENE MEEKS/GIA COLLECTION

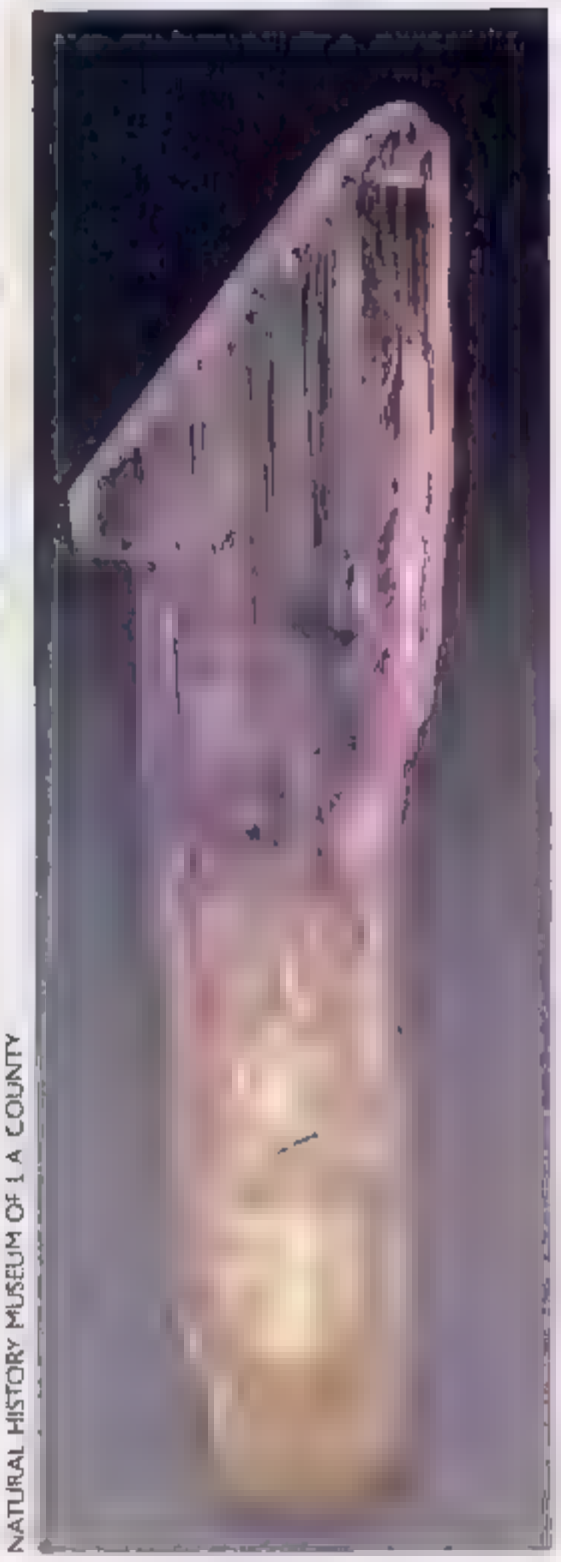
The Tourmaline Queen Mine in Pala, California, produced this elbaite, colored by lithium.

CLIFF VERMONT COLLECTION

Tourmaline is a cyclosilicate composed of a ring structure that typically forms a very strong, often elongated crystal.

WAYNE THOMPSON MINERALS

Microcline, variety amazonite, here with smoky quartz, will also be found with tourmaline and spodumene in some gem pockets.



NATURAL HISTORY MUSEUM OF L A COUNTY

It's almost certain that spodumene, a lithium aluminum silicate, will be found in lithia pockets in pegmatites.

Due to the complexities of this gemstone, its density and coloration are influenced by changes in tourmaline's atomic and chemical structure, plus the influx of foreign elements. The slightest variation during the process of formation will have changed the color of tourmaline considerably.

Tourmaline is found in both equant and prismatic forms and comes in many varieties; the various shades of orange and brown tourmaline are called dravite, black tourmaline is schorl, pink to red and several shades of purplish red are rubellite, a similar reddish-purple crystal from Siberia is called siberite; a blue variety is indicolite, green-and-pink-zoned is called lithia, and white tourmaline, although quite rare, is called lime-dravite. The colorless variety achroite is a scarce commodity.

I had a hands-on experience searching for this mineral while on a field trip to that famous community of Hiddenite, North Carolina, some years ago. This bustling little city is east of the Blue Ridge Mountains. One of the specimens I collected was a schorl crystal. It was so dense that I couldn't see any translucence at all in the stone when I held it next to a bright light. That one black tourmaline, plus some pretty reddish-purple rutile crystals, was my reward for digging in a pit for emeralds. All the while, in the back of my mind was the hope that I might discover other rare gemstones. I knew conditions were not exactly right for spodumene, but it was a very good bet that tourmaline was present.

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Tourmaline and Spodumene *from page 81*

The hexagonal prismatic tourmaline crystals are the most predominant. They are composed of silicate of boron with aluminum. The composition is quite complicated, and can have many alterations. As an example, the formula for lithia is $Na(Al,Fe,Mn,Li,Mg)_3B_3Al_3(Al_3Si_6O_{27})(O,OH,F)_4$. Its Mohs hardness can vary from 7 to 7.5 and its specific gravity from 3 to 3.5. It's a brittle mineral, striated lengthwise, with poor cleavage. The fracture is conchoidal, and the crystals can be long, or at times stubby, and transparent, sometimes opaque. The luster is vitreous, and when tested on a streak plate, the color is white. The most intriguing thing about tourmaline is the great variation of colors, quite often distinctly zoned, with several in one crystal. The green-and-pink crystals (watermelon tourmaline) are highly prized, and are often displayed uncut as cabinet specimens. The tourmalines are much sought after for gemstones in jewelry.

One other unique and unusual feature of tourmaline is that it generates a piezoelectric current. When a thin slice of a crystal is compressed, it gives off a charge of electricity. This characteristic is caused by its strange atomic structure. It has many industrial uses in gauges and other electronic configurations.

How this gemstone was colored has been a dispute for a long time. We do know that the elements, lithium, manganese, iron, and cesium all have played a part in this phenomenon, either singly or in combination, to produce those wonderful colors of the spectrum.

Tourmaline forms in pegmatite gem pockets in granite. It will also be discovered in cracks in igneous veins, along with other minerals. A typical gem pocket might consist of tourmaline crystals mixed in with quartz growing from the ceiling, along with feldspar, muscovite mica, beryl, and doubly terminated tourmaline crystals or crystal fragments, plus often distorted quartz crystal fragments "floating" in the pocket. It will also be found with spodumene, microcline and lepidolite in some gem pockets.

This gem "cavity," which is often completely filled from top to bottom, will contain a hard clay substance. This clay can be so hard and sticky that a pick must be used to loosen it. It can adhere to digging tools with great tenacity, making the removal of any gemstones a real chore.

The most common color of gem tourmaline is green. This green will be found in a multitude of shades, including brownish-green. As a matter of fact, all the various colors and combinations thereof have the tendency to blend together.

Dichroism in tourmaline is quite strong and can be seen in even the weakest-colored crystals. As an example, a pink crystal may sometimes appear to be pale yellow when viewed through a dichroscope. The change is often quite pronounced in all crystals examined.

I once had the rare opportunity to work a pegmatite dike in an igneous outcrop in northern Minnesota. It was a fissure about 15 inches wide at the widest and approximately 45 feet long cross-cutting the granite. It tapered off to a point at one end and was blunted off at the other. For much of the length, it wasn't wide enough to actually get down into it, and that made collecting difficult. The pegmatite contained a very hard, cream-colored clay the consistency of weathered, gummy concrete, in one cohesive mass. The walls of the dike were near vertical and it made a jagged, wavering intrusion in the granite for its entire length. I don't know how deep it was. I never had the chance to find out because it was in an active iron mine and the next cut with the huge electric shovel would soon destroy it. As far as the scientific and intrinsic value of that dike was concerned, it was simply overburden that had to be removed in order to reach the iron ore.

I visited and worked the site two times briefly. The third time I went there, they had already drilled a pattern of holes in the area and filled them with explosives in preparation for a blast, and I was not permitted to enter.

I did manage to collect several nice smoky quartz crystals. A few are what I would call incomplete because they are lying on their side in the matrix with only three faces showing. One specimen I collected is 9 inches by 7 inches by 5 inches and weighs 29+ pounds. The bulk of this mass consists of the granite matrix. Several short stubby crystals surrounding this rock are semitransparent with so many black inclusions they appear to be solid black. One side is partially covered with golden drusy quartz. The specimen also contains an area of milky quartz, with no distinct crystal structure. It was cemented to the line wall of the dike, and the adhering side is perfectly flat. With much effort, I had to pry it loose with a gad and fish it out with a shovel after removing the clay around it. I was working by feel and was afraid that I might fracture the crystals, but I didn't.

Some of the specimens were at a depth of 3 feet or more, including the big one. I also managed to remove a beautiful emerald green quartz specimen with several perfect stubby hexagonal crystals perched on its igneous matrix. It was a magnificent specimen the size of a man's hand.

Amazonite is a potassium feldspar that occurs in pegmatites, where tourmaline and spodumene are also found.

I didn't have the opportunity to investigate further and never did find out whether the dike contained a gem pocket. As I think back, the conditions were right for it. I didn't find any tourmaline or spodumene, however. If I had, it would have been a first for this part of the country. I prize the large mass of smoky quartz, but it's actually too big to put in my display cabinet, the weight might crack the glass shelves.

I gave the green specimen to my mother, and over the course of time, it disappeared. I would dearly like to have that green quartz specimen today. It was one of only two that I have ever seen.

Gem-quality tourmaline has been collected in a number of diversified locations. Mount Mica in Oxford County, Maine, is noted for its beautiful green specimens. A wealth of multicolored crystals, including the watermelon type, have come from the famous pegmatites in San Diego County, California. Some fabulous color-zoned crystals have come from Baja California Norte, Mexico. This mineral has been found in the Yellowknife area of Canada's Northwest Territories, some has come from Ontario, Quebec, Mount Apatite, Maine, New York state, Colorado, and New Mexico. Small gem-quality crystals have been collected from pegmatites in the vicinity of Keystone, South Dakota, but most specimens from here are not gem quality.

Spodumene, a lithium aluminum silicate, is found in equant and prismatic form. The name is derived from the Greek word "spodoumenus," meaning "burned to ash" in reference to its somewhat ashy appearance. (I personally think that's a strange definition, and not at all appropriate.) It's almost certain that spodumene will be found in lithia pockets in pegmatites. The crystals are in the monoclinic system. In other words, they have three unequal axes, with one slanting or oblique intersection. The mineral forms flat, lathlike, striated crystals, sometimes pointed like a sword and other times rounded off at the tip. Crystals will often have deep cracks along the cleavage planes. Its formula, $LiAlSi_2O_6$, is much less complicated than tourmaline's. Its gem-grade crystals are beautifully transparent. Its Mohs hardness is 6.5 to 7, a bit softer than tourmaline. Its specific gravity is from 3.1 to 3.19, and could even go as high as 3.23 in some instances.

continued on next page

Tourmaline and Spodumene *from page 83*

Gem-quality spodumene glistens with a high glassy luster. Massive spodumene also has that glistening quality, but unfortunately, it is opaque. In many respects, the massive type resembles milky quartz in appearance. Much of it has pressure fractures. It is an important source of lithium, a soft silvery metallic element of the alkali group. It's the lightest metal in existence with a specific gravity of 0.53, and is an important mineral in industry.

The various types of gem spodumene are identified only by color. The first discoveries of any importance were made near Pala, California, and the material was named kunzite for the late Dr. G.F. Kunz, the gem expert from New York. The best crystals have come from the prolific mines in the Pala district.

Kunzite crystals vary in color from many shades of pink to various shades of purple and violet. It has two poor qualities for a gemstone, besides its softness: the color tends to fade out after long periods of exposure to light, and it has two perfect cleavages, making it quite difficult to cut without fracturing along one of these cleavage planes. Once the cleavage challenge is overcome and kunzite is faceted into a gemstone, it demands a premium price.

Hiddenite is the intense emerald-green variety of spodumene. This species is only found in Alexander County, North Carolina. To date no other source for this green gemstone is known. W.E. Hidden discovered it near the town of Stony Point, approximately 10 miles southeast of the community of Hiddenite, in 1879. Hiddenite has all the good qualities, along with the inadequate tendencies, of the former. One plus for hiddenite is that it doesn't fade out when exposed to light like kunzite. The colorless-blending-to-yellow crystals of this mineral are called triphane.

My experience with spodumene is a story in itself. Although I haven't yet had the opportunity to collect gem-grade material in the field, I did collect the massive type while on a trip in eastern Manitoba, Canada. At a tantalum mine in Bernick Lake, I was able to collect some very nice cabinet specimens. One of the products of that mine was common spodumene. I was given a personal tour by the superintendent working there at the time. We suited up in coveralls and a hard hat, with a lamp and battery pack. We climbed aboard a specially built low-slung roofless jitney with seats for half a dozen miners, drove right into a tunnel at the surface, and descended into the mine. The main body of this mine, by the way, is right underneath Bernick Lake! While underground, I saw no sign anywhere of water leaking down from the lake bed. The mine was dry.

When we stopped at the work faces where the miners were drilling and loading ore, it was impossible to hear anything over the ear-splitting noise from the air drills and earth moving equipment in the area. We had to use sign language to make ourselves understood. When we returned to the surface, it was hard to believe that I had spent four hours underground. It seemed like only a few minute had gone by.

As I write this, I'm looking at one of those cabinet specimens collected at that underground mine. It is not gem grade by any stretch of the imagination, but beauty is in the eyes of the beholder. The end product of this type of common spodumene is, of course, lithium. My cabinet specimen is 5 inches by 3 inches by 3 inches. The crystal is rectangular with oblique almost perfectly flat faces. It is milky white with a very glossy surface.

One interesting segment of our hobby is being able to identify minerals in the field. For instance, is it actually the crystal you think you've found or a look alike? Basic tools for identifying minerals in the field are an eye loupe of at least 6 power or a hand magnifier for examining the inner structure of crystals, an unglazed porcelain tile for streak testing and a streak color chart for comparison, a hardness kit, and a small magnet to test for iron. If you don't posses a hardness kit, your fingernail has a hardness of Mohs 2.5, a penny is Mohs 3, your pocket knife blade will be Mohs 5 to 5.5, a steel file is Mohs 6 to 6.5, and a piece of common quartz is Mons 7. Some identification kits include hydrochloric acid for testing carbonates. I would not recommend carrying it, particularly when children are along on a field trip! It's risky enough for grownups.

So after all is said and done, the many varieties of gem-grade tourmaline and spodumene are special minerals, fit for royalty and commoner alike. As the saying goes, if we play our cards right, maybe we, too, will discover one or more of these wonderful gemstones on our next field trip. The possibility is always present. All it takes is a positive attitude and perseverance.

FIELD TRIP

Return to Ladds Mountain

An endcut from a 30-pound piece of flowstone on sandstone matrix shows excellent red and orange colors

The Only Place to Collect Cave Formations

Story and Photos by Richard Jacquot

While the mountains of Western North Carolina, with fairly mild winters, provide pretty much year-round collecting opportunities, there are rare occasions when the weather can force even the most hardcore collector to stay indoors. I can usually find plenty to keep me busy during these harsh winter days: cleaning, labeling, cataloging, and mounting specimens. Sometimes, to mix things up a little and get away from my mineral collection, I pull out my past issues of *Rock & Gem* magazine and read about other people's minerals and field trips.

One evening, while thumbing through the November 2004 issue, I came across an interesting story titled "Ijon Gorge Travertine," by Michael Walter. I had enjoyed reading the piece the first time, and as I was re-reading it, I got to thinking of a location not too far from Western North Carolina that my son and I had always enjoyed, but had not been to in

quite a while. The location, called Ladds Mountain or Ladds Quarry, is in Cartersville, Georgia, north of Atlanta, about a four-hour drive from our home in Asheville, North Carolina.

Not a big mountain, Ladds rises maybe 200 feet above the ground. Ladds Quarry was worked commercially from the late 1800s into the 1940s for limestone. During the mining operations, complex underground caverns and passageways were uncovered that contained beautiful formations of speleothems (also known as cave onyx), stalactites and stalagmites. The mineral name for these formations is travertine. Found in limestone caves throughout the world, travertine can form striking and unusual formations (the stalactites and stalagmites).

Water seeping through the ground from the surface makes its way into these underground caverns, picking up minerals along the way. The water deposits the minerals into the caverns, creating the travertine formations. Stalactites form on the ceiling and walls of caves and resemble icicles. Stalagmites grow upward from the floor of the cave. In many places at Ladds Mountain, the stalactites and stalagmites have grown together into a column.

The amount of surface water, the types of rocks in the area, and the amount of moisture in the air play an important role in how these caves are formed and the amount of time it takes to form them. Often when a cave system such as this is discovered, it is preserved and protected for future generations to enjoy. I have made many trips with my family to visit the magnificent caverns in Virginia: Lurray, Grand Caverns, Endless Caverns, and others. Kentucky has the Mammoth Caves, North Carolina has the Linville

This is a fine example of a twin stalactite. You may still find pieces with good tips in pockets in the quarry walls.

Caverns, and Tennessee has more than 8,000 known cave systems. Let's not forget some of the most famous caverns: Carlsbad Caverns in New Mexico and the more recently discovered Kartchner Caverns in Arizona.

Unfortunately, at Ladds, the majority of the caverns were destroyed during mining, and countless specimens were buried in the dumps at the quarry. Today, Ladds Mountain is owned by Bartow County, Georgia. The county uses the old quarry area as a landfill for road construction debris. There is also a firing range at the site that is used by local law enforcement agencies.

While I support the efforts of the various cave preservation organizations and understand their desire to protect and preserve these underground caverns and the unique formations found within them, when I look at Ladds Mountain, the collector in me takes over. Over the past few years, each visit to the site has found more and more debris being dumped into the quarry. I feel that collecting and preserving the travertine formations for public and private collections is a far better fate for them than being eventually buried forever under tons of rubble.

My first trip to this site was in 2000. My son R.J. and I had joined a local mineral club on a field trip to the mountain. As happens often when I visit a new site, I spent most of my time trying to figure the place out and a little time trying to find something worthwhile to bring home. By the end of the day, we had found a few nice specimens and had a good idea of where we wanted to search when we returned. A few weeks later, I arranged another trip to the site for the two of us.

Upon arrival at the mountain, we stopped in at the maintenance building located near the entrance of the quarry. We signed in with the watchman, and he went over the rules for collecting: no climbing to the top of the mountain to collect, collect only at the base of the mountain and in the old dump material, no rappelling off the walls, and no entering what is left of the underground caverns.

According to the watchman, a woman had climbed the mountain a few years before and had accidentally fallen to her death! In the caves, it's possible to contract a rare disease called histoplasmosis by disturbing the fungus histoplasma capsulatum, which occurs in bat guano, and breathing in its spores. (To learn more about histoplasmosis, visit my Web site, www.wncrocks.com, and check out the resource page and the section on Exploring Old Mines.) There is also the danger of cave-ins inside the passageways. During mining, the use of dynamite caused much damage, making what is left of the underground tunnels unstable. Collectors must also return to the maintenance building at the end of the day to sign out and let the watchman know they are leaving. This is done for safety reasons and helps account for everyone entering the property.

After checking in, we made our way to the old quarry area and spent the day collecting many excellent specimens. At the end of the day, R.J. said it had been the most enjoyable trip he had been on with me, and he was ready to plan the next one. Well, that was a few years ago.

continued on next page

This unusual bubbly piece started as a stalctite, but when it ran out of room to grow, it mushroomed outward.

This piece shows an unusual pancake form. The small circle in the middle was a hollow stem that held the piece to the ceiling of the pocket.

Return to Ladds Mountain *from page 89*

As I sat reading the Ilion Gorge article, I decided it was time to return to Ladds Mountain. It took me two weeks to make the arrangements. I had to clear a date with the Cartersville P.D. and the local Sheriff's Department, as no one is allowed at the quarry when the shooting range is in use. I set up a trip for our club, the Mountain Area Gem & Mineral Association (MAGMA) for April 2005. R.J., now 16, has been more interested in girls and music the last few years, but when I told him we were going to Ladds, he was packed and ready to go in no time.

We arrived in Cartersville Friday evening to be ready for our day at the mountain Saturday. We met around 30 other club members at the Weinman Mineral Museum, also located in Cartersville. In my opinion, the Weinman is one of the premier mineral museums in the Southeast. It hosts an excellent display of minerals from Georgia and around the world, as well as several nice specimens from the Ladds Mountain site. (For more information about the Weinman Museum, visit www.weinmanmuseum.org.) After a tour of the museum we headed to the quarry.

R.J. and I were the only members to visit the quarry prior to this trip, so we directed everyone to the maintenance building and then led the group to the collecting area. Members dispersed across the quarry floor, searching the dump piles and the ground at the foot of the mountain for specimens.

There is one opening in the side of the mountain that extends just a few feet inside, but in that few feet you will be able to view firsthand what a fantastic cave system this was in the past. The walls are covered with thick layers of rolling flowstone. In the ceiling, you can see many nice stalactites hanging out of reach of the collector's hammer. All the stalagmites were removed years ago by visiting rockhounds, but you can still see ringed patterns of travertine—they resemble the rings in a piece of petrified wood—marking where they had formed.

Flowstone, or cave onyx, is also made of travertine. In many cases, when cut on end, the flowstone will display intricate patterns and banding, which gives it the name cave onyx. Much softer than actual onyx, cave onyx can be hand polished and makes nice cabinet specimens. The color of the cave onyx at Ladds is generally an orange-red due to the mixture of iron oxide. Some specimens are composed entirely of white calcite and will fluoresce a bright yellow-white under shortwave ultraviolet light.

The Weinman Mineral Museum has a selection of nice specimens from the Ladds Mountain site.

Outside, on the walls of the mountain, there is still plenty of flowstone that can be collected. It takes time to liberate the onyx from the limestone with a sledgehammer and chisel, but the specimens are well worth the effort. Throughout the day, the club members discovered a variety of interesting and unusual specimens for their collections. Collecting these formations is not an opportunity many rockhounds get; the majority of caves and caverns in the United States are protected by private property owners and the federal government, so having the chance to add some of this material to our collections makes the specimens even more special. Ladds Mountain is one of the only locations in the Southeast, and maybe the United States, where you can legally collect cave formations.

Other minerals collected were fragile, needlelike crystals of white aragonite, formed in single crystals and clusters on the surface of some of the travertine specimens. You can also find the unusual helictites, which may be the most interesting pieces collected at Ladds. Helictites start as small stalactites, but while they are forming, their chemical composition is altered, causing the formations to grow in all directions and take on many odd shapes. I found many pockets in the walls from which I retrieved some of these pieces. Some of the members and the younger children were able to fit into cracks and crevices that I was unable to reach into. They came out with some of the best specimens. By the end of the day, all our members were quite pleased with their finds and we declared this to be one of the best field trips we had been on as a club.

I have acquired many specimens at Ladds Mountain and I plan to share them with the public. I am currently working on a display for shows throughout the Southeast that will show some of the more beautiful and unusual pieces I have found. Pictures of the display will appear on my Web site, www.wncrocks.com, when it is finished.

To get to Ladds Mountain from Atlanta, take Interstate 75 North to state Route 113. Take the Cartersville exit and turn left (west). Follow state Route 113 through town approximately three miles. You will see Ladds Mountain on the right. Go through the gate and follow the paved road to the maintenance building to sign in. Remember to clear a date with the Cartersville P.D. and the Bartow County Sheriff's Department. Have fun!

Mining destroyed the cave systems at Ladds Mountain, and countless specimens were buried in the dumps at the quarry, now used as a landfill.

On The Rocks

Digital Camera Pros and Cons

For the last 40 years or more, I've been using the traditional 35mm film camera to shoot minerals. I shot both slides and prints, since my needs varied. Sometimes, I'd haul out my Mamiya RB 67, which requires a sturdy tripod for support. Some years ago, I even worked with a 4-inch by 5-inch Graphic, but film for that got pretty pricey. The products from these wonderful photographic devices have always been useful and sometimes even great in spite of my limited skills in photography.

Some of you know that for years I resisted using a computer. After all, I'm from the John Sinkankas school of writing: Use a yellow tablet to put down your ideas, then turn to the typewriter for copy. As John was my mentor in many ways, I always thought his way was the better way. Eventually, I discovered the word processor, which is very much like a typewriter, except you can put your work on a diskette and correct it without using white-out! The word processor didn't challenge my technical ignorance too much, so I managed it nicely.

For ease and convenience, my digital camera has it all over the Mamiya RB 67 camera I used for so long—and will continue to use.

But in a bow to progress, I finally succumbed to buying and using a computer. In spite of some real problems yet to be resolved, I find a computer eminently useful, though sometimes frustrating.

Once I got a computer, it was inevitable that the next step in progress was to thrust a digital camera into my hands! Not that I have forsaken my film cameras, but I am slowly using a digital, sort of like dipping my toe in water to test the temperature! So far, I like what I find, but the good old film cameras still have uses. For those readers unwilling to make the leap to a digital camera, let me share some of my thoughts on film cameras.

Readers have often asked what kind of lighting I use with my film cameras. I need two different sets of lights. One set I use at home or locally, where the volume of equipment can be managed. This includes light stands and reflectors because the lights I use simulate sunlight. This means I can use daylight film, which is readily available and easy to get developed. All that equipment is bulky, but easily available. I use Daylight Blue light bulbs, 150 watt bulbs that recreate sunlight. I can make set ups, use daylight film for both prints and slides, and get commendable results.

But hauling light stanchions, cables and the like all over the country and the world gets a little tedious. I've taken my equipment to England a couple of times. On one trip to photograph the Phillip Rashleigh collection in Cornwall and the Russell collection at the British Museum of Natural History, I hauled all that gear in a big suitcase, along with a transformer to convert the more powerful European current down to our standard 110 volts. Unfortunately, my transformer blew out while at the British Museum and I had to borrow a big one from their electrical department to make the trip out to Cornwall.

This particular museum transformer came in a huge wooden case with a dial on the side and a handle on top. Carrying that beast on the London underground was no fun; it weighed about 60 pounds. In fact, when we left the underground, we dropped into a nearby pub to see what was going on. I put my transformer down and took up station at the bar. Suddenly, I realized the place had emptied out and a Bobbie was striding toward me. He asked about the wooden case and was relieved to learn it was a transformer, not a bomb!

For traveling, especially where plane travel was involved, I determined that I needed a smaller assortment of photographic gear. So I switched from daylight film to tungsten film and left my big lights behind. To replace them, I use three or four small Tensor desk lamps with 12-volt bulbs. It so happens these particular lights give off the correct light for tungsten film. The light is not brilliant, so long time exposures are required, and this means a tripod has to go along. The long-time exposures worked well with what I was trying to accomplish, which was depth of field in my photos.

Depth of field is an attempt to make mineral specimens look like the three-dimensional objects they are. A good photograph of a cluster of crystals gets all the crystals in focus. You can't accomplish that without good depth of field. Nothing is more distracting in a mineral photograph than to see part of the crystal cluster out of focus. To increase depth, you have to shut down the lens to its smallest opening. I like to use f-32, and let that determine the time exposure, which can range from one second to multiple seconds.

Even though I need a tripod to go with the little Tensor lamps, the equipment is scaled down enough to make my photographic travels a bit easier!

I'm not about to give up on my film cameras, but for ease of travel and for convenience, my digital camera has it all over the film cameras. It is handy, easy to use, lets me see any photo I take instantly, and travels anywhere. For shooting minerals indoors, I still need lights, but I can set up outside in very bright shade and get good results, since my digital camera will automatically adjust settings. With three-dimensional specimens, I still need to alter the lens settings to a small aperture and long time exposures.

There are also some real drawbacks to the digital. For one thing, I have to have a computer to go with it. All the shots I take have to be put on file in that infernal contraption so they can be transmitted to a CD for use. The advantage is that the computer, once hooked up to a printer, can also spit out as many copies of the photos as I want.

Which brings up another problem: creating a file system that will allow me to retrieve those same shots from the computer with some sort of ease. All this takes real time, something I find in short supply as I get older! Of course, for the average person with a digital camera, the local drug store nicely replaces the computer. They'll take the memory stick from your camera and produce your photos in print form.

For me, there is another drawback with the digital. I give lots of talks using slides. I have not gotten into the mysterious world

of PowerPoint yet, and digital cameras do not take slides! Those of you who have heard me lecture know slides are like my right arm; I can't do without them. So I always carry my good old film camera loaded with slide film!

If you think I'm completely against digital cameras, think again. One plus with a digital is its aim and shoot mode when it is on automatic. If the lighting is adequate, this is a great boon to the camera slinger! I really like that feature because I don't have to think, and thinking tends to confuse me! The other real plus is that if you take a really lousy photo, you can dump it and take another right then. If the photo you took is marginal but has some redeeming features, you can use the computer to turn that photo into something quite commendable. Shades of Ansel Adams and his darkroom!

Certainly, the convenience of a digital camera for taking pictures of minerals on display at a show far outweighs the negatives I mentioned above. The problem is that most display cases use ordinary household lights and they give off an inordinate amount of yellow light. That's why your daylight film tends to give your show photos a yellow cast. One answer is to go to a camera shop and buy a filter that will compensate for the yellow. Or with a digital camera that is a little more advanced, you can set your camera to handle the lights.

Of course, I use a high-end digital camera because I need high-resolution photos for reproduction. It is not something you can stick in your shirt pocket, but my requirements are rather special.

As for lighting, the digital camera does not need anything special as long as it has settings to adjust to the light source. You can use your computer to further adjust colors in the photo. Or as suggested above, shoot things in bright shade, and the digital works its magic!

When you get a good picture with your digital camera and get it into your computer, you can produce as many copies as you can afford photographic paper. You can send pictures to all your aunts, uncles, cousins, and even your enemies, if you want to make them jealous.

My point is that in spite of some of the digital camera's annoying shortfalls and complications, for the average rockhound who wants to get a shot of a nice crystal group found in the field or seen on display at a show, a good digital with a zoom lens is pretty ideal. And the smaller ones are cheaper than a good 35mm film camera. If you don't want to mess with a computer, take the digital card to the local drugstore, and they'll print your pictures just like processing pictures on film. How convenient is that?

One caution about digitals: They produce photographs by the dot method. That means the photo is actually a series of microscopic dots that form the whole. A small print from such a picture is fine, no visible dots. But reproducing such a photo in a magazine reveals all those little dots unless your camera records a high number of dots per inch (dpi). Any digital photo submitted to *Rock & Gem* has to be 300 dpi and submitted on a CD. So if you plan on submitting digital photos to *Rock & Gem*, first obtain a copy of our Writer's Guidelines, which explain all that, before you go capturing every crystal in sight with your digital camera. The guidelines are available from the *Rock & Gem* Web site, www.rockngem.com, or by writing to **Writers' Guidelines, *Rock & Gem*, 290 Maple Ct., Ste. 232, Ventura, CA 93003.** Better yet, call editor Lynn Varon at (805) 644-3824 extension 29 for a more detailed explanation.

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About the time you read this Europe's great gem and mineral show, Mineraleintage Munchen, is just a couple of weeks away. I've been there several times, and each visit has been enjoyable.

Everybody's favorite amazonite and smoky quartz locality, near Pike's Peak, Colorado, will undoubtedly be chosen for the special exhibits at Tucson 2008.

The special exhibits, the huge number of dealers, many of whom never visit the United States, and the sightseeing that goes with visiting this lovely country all make the trip really worthwhile.

The theme for the 2005 Munich show is Agate, one of my favorite subjects! I find these massive quartz formations utterly fascinating because of the endless variety of their colors and patterns. The uniqueness of agates is one of their strengths.

Agates are found all over the world, and the Munich show will display suites of agates from every major source, including the historically important Idar-Oberstein region of Germany.

Of special interest for agate lovers will be the David Wilber collection of matched Condor agate pairs. Most agates are cut into slices to get the maximum re-sale or trade value from the one rock. Wilber has eschewed the economics of cutting up agates by obtaining and preserving complete nodules that have been simply cut in half and polished. The Condor agate source in Argentina was discovered by Luis de Los Santos (see "Argentina's Condor Agates," September 2005 *Rock & Gem*). My article about Luis, Dave and this unique collection will be a featured attraction at Mineralientage Munchen, the last week in October.

* * *

It's time to give you a preview of what will be happening in Tucson in 2008. Granted we haven't even had the 2006 show yet, but the 2006 exhibits require such long-term planning that efforts are already in motion.

Two friends, Gene Meieran and Shields Flynn, came up with an amazing idea. They decided a fantastic display for the 2007 Tucson Show would be to bring together a series of exhibits, each featuring one of the greatest mineral finds made in the United States since 1950. When they included me in the discussions, it was obvious to me that the year 2007 was too soon, so we decided 2008 should be the target year.

The plan requires a lot of work, but is pretty straightforward: ask leading collectors and dealers to suggest what mineral finds should be considered; compile that list and submit it to a large number of dealers and collectors; and have them vote on which of the recommendations should be considered. It was thought that such a vote would identify about 20 important finds. The initial list was put together and sent out for a vote. That cut the list of maybe 100 suggested localities down to a manageable number. Then that second list was voted on. As of this writing, the last vote is coming in, and it looks like more than 20 localities will end up on the select list. I'll be including more information on this in future columns.